Use of the Software BIOMECHANICS in Physical Culture and Sports Specialists’ Preparation


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Abstract - The use of computer technologies allows to form the theoretical knowledge and practical skills of future physical culture and sports’ specialists qualitatively. Software Biomechanics was developed in order to improve the assimilation of biomechanical knowledge and to increase the level of kinesiological competence of students of Kharkiv State Academy of Physical Culture and the Institute of Physical Culture of Makarenko Sumy State Pedagogical University (Ukraine). It includes educational and methodological information that enables the student to acquire practical skills and abilities for the independent use of the theory and methods of biomechanical measurements, biomechanical analysis and didactics of motor activity in physical education and sports training. The software contains different parts (theoretical, practical, references control). The practical part provides the execution of calculation and graphic works aimed at determining the geometry of human body mass, measuring the kinematic characteristics of motor actions, finding the center of masses by analytical and graphical methods etc. The software enables physical education and sports’ professionals to train with the use of basic biomechanical positions, to improve motor programs, and to promote health and safety in the process of physical education at school as well as in the performance of sports coaching and physical rehabilitation of patients and athletes.

Keywords - computer technologies, internet resource, biomechanics, kinesiological competence, physical culture and sports specialists.

I. INTRODUCTION

The state policy of implementation the information technologies in the field of physical culture and sports is governed by relevant regulations and state programs. We should mention the Law of Ukraine "On the Basic Principles for the Development of an Information-Oriented Society in Ukraine" [5] and "Strategy for the Development of the Information Society in Ukraine" [6] approved by the order of the Cabinet of Ministers of Ukraine (May 15, 2013). Also we can mention the order of the Cabinet of Ministers of Ukraine "On the Approval of the Concept of the Development of the Digital Economy and Society of Ukraine for 2018-2020 years and the Action Plan for Its Implementation" (January 17, 2018) [7]. According to the Annual Global Outsourcing Industry Analysis "Global Service 100" Ukraine ranked the 11th place in the top of 20 the largest global centers for the number of people employed in the field of information technology.

In the modernizing process of the Ukrainian model of physical culture and sport development, the computerization of this field plays a significant role. It is shown by findings devoted to the use of information and computer technologies in the process of physical education and sport [1; 4; 8; 10; 11]. Also it is shown by the computer analysis of athletes’ movement technique in accordance with biomechanical parameters, adaptive models of athletes' capabilities and their reactions to physical activity in different intensity zones, software for analyzing a large number of individual parameters of the athlete, computer multimedia systems which manage various aspects of physical education process and sports training etc. independently.

In modern education, the process of professional training of future specialists in physical culture and sports is also inextricably linked with the implementation of the modern information technologies achievements. However, the list of such electronic means, that would allow the qualitative formation of theoretical knowledge and practical skills of future specialists in physical culture and sports, is described deficiently in literary sources. Therefore, this issue is relevant today.

A. An overview of recent research

The analysis of scientific and methodological literature has allowed identifying several groups of possibilities for using IT in the theory and practice of physical education and sports.

The usage of IT in conducting sports events as a tool of sports management. It includes the solutions for logistic tasks of regulating the flow of athletes and spectators, planning financial and demographic aspects, advertising and information support for sports events, financial and legal affairs. The use of IT in sport management is explained not only by the fact that these investments have high rates of return and they lower the estimated cost of the event, but because IT’ development is an investment in local infrastructure. An example is the "Automated System for Holding of Sports Competitions" [3] and Heracles (www.unitedworldwrestling.org).
Training complexes using information technology provide:
- the possibility of objective analysis and tracking of such complex phenomena as trajectory of movement or maintaining equilibrium in the formation of motor skills and abilities (video analysis of movements);
- the possibility of modeling rare and atypical situations, as well as solving problems of forecasting by using virtual reality systems;
- the possibility of registering athletes’ indices for the analysis of the objective assessment of the technical and tactical actions of each and the results achievement on-line;
- biological feedback systems (biofeedback) allow to create conditions for registration, amplification and “return” of physiological information to the patient.

The “BioVideo” software [8] is considered to be one of the most comprehensive application software, because it allows to perform biomechanical video analysis based on videograms (video footage) and to obtain quantitative biomechanical characteristics and a graphical model of movements scheme of the object being studied.

Research work or medical and biological support. IT plays the important role in research work, because it allows scientists to perform complex mathematical calculations and to handle significant arrays of numerical data in a short time that assesses physical fitness and athlete's health. An example of the successful use of IT to monitor an athlete can be found in the following software: an international system for collecting and processing information "Athlete Biological Passport" developed by the World Anti-Doping Agency (www.wadaama.org/en), ergometers and exercise devices, the software "Organization of athletes' nutrition" [10], "Coach's journal" and “Health analyzer” [9]; the "Check" device to stimulate a specific neuromuscular reaction of the brain; new generation of FuelBanS bracelets; the Goji Play system, which allows you to combine training with a video game on the simulator.

**IT as a means of fixing sports results** ensures the rapid collection, transmission, storage and processing of a large amount of information. Specialized tachometers, based on Global Positioning System (GPS), sports timing technologies, integrated with the system of electronic scoreboard are widely used. An example of more accessible video analysis software is Kinovea [2], which is designed to view and analyze the sports video and video analysis of movements.

**IT is actively used in the training of future professionals**, that allows you to create a comfortable environment both during the theoretical studies and in the process of training by means of the visualization of educational materials, what contributes to the development of practical skills of the correct technique of motor activity. Examples of such software will be discussed later.

**II BIOMECHANICS SOFTWARE**

**A. Biomechanics as a subject of study**

Biomechanics as a subject in higher education institution of physical education and sport belongs to the disciplines of the natural sciences and the methodological kind of professional knowledge. Biomechanical knowledge is an important component in the structure of the modern system of European pedagogical education in the field of physical culture, and the biomechanics as a discipline is taught in 73% of European universities.

The subject of study of the discipline is the biomechanical characteristics of the body and motor activity of a person performing physical exercises in different conditions. The biomechanical aspects of motor activity and biomechanical rationale of physical exercises as the main means of physical education, rehabilitation, recreation and sports training are also studied. The subject of the study is also biomechanical analysis of motor activity, pedagogical process of teaching motor actions and their correction, biomechanical modeling of human motor activity in different conditions with the aim of substantiating the individualization of the pedagogical process in physical education, sports and physical rehabilitation as the main way to increase their effectiveness.

To understand the essence of human motor activity and the complexity of managing them it is not enough to know the basic laws of mechanics and ways to describe the external image of the movement. It is necessary to consider the laws of physiological phenomena, the biological nature of the interaction of the organism with the environment. This is why the study of this course is closely related to such disciplines as anatomy, biochemistry, physiology, psychophysiology, functional systems theory and many other sciences.

The discipline has close interdisciplinary connections, because it takes into account the previous knowledge of students in such disciplines as "Human Anatomy", "Human Physiology" and suggests the possibility of using the obtained knowledge in the course of studying the following disciplines: "Theory and Methods Physical Education", "Metrological Control" and "Physical Rehabilitation".

Firstly, it is necessary to be guided by the principle of "do no harm" when applying software to train students in biomechanics, because the computer cannot become a means of solving all problems of education. V. M. Bogdanov, V. S. Ponomarev, A. V. Solovyov, T. V. Utkin focus on the expediency and effectiveness of the use of electronic teaching materials in the preparation of future specialists in physical education and sports. P. K. Petrov, O. B. Dmitriev, E. R. Akhmedzyanov consider the use of diagnostic system of knowledge level in biomechanics on the basis of modern information technologies. V. S. Ashanin, L. V. Filenko, O. V. Basenko, S. S. Pyatisotskaya, S. V. Garkusha,
N. P. Bateev studied the development of an innovative teaching methods based on the integrated using of computer means and biomechanical methods.

Using of the software will help future physical culture and sports professionals to study the biomechanical foundations of human activity, pedagogical means and methods of its optimization aimed to improve motor activity in order to achieve planned results in physical education, sports, as well as in physical rehabilitation and recreation.

**B. Biomechanics software**

In order to improve the mastering of the biomechanical knowledge and to increase the kinesiological competence level of students of Kharkiv State Academy of Physical Culture, an educational and methodical software for the discipline “Biomechanics” has been developed (http://biomechanika.pp.ua/). The main window is shown in Fig.1.

![Fig. 1. The main window of the educational and methodical software Biomechanics](image)

This software was being created by using the WordPress platform. This platform is used as a management system for educational content and an educational process for conducting on-line courses and interactive education.

The content was formed in accordance with the curriculum in this discipline. The form of representing the information allows the user to choose the training material necessary for study.

The information resource contains the following sections:

- educational-methodical literature (including lecture material, as well as laboratory workshop with the implementation, drawings, tables and control questions at the end of each work) (Fig. 2);
- themes of independent work;
- themes of individual tasks;
- requirements for formalizing the individual tasks;
- an example of calculating and graphic work;
- tests for extramural students;
- exam questions;
- examples of sports tasks;
- recommended literature;
- articles on the subject of biomechanical research.

![Fig. 2. The window with educational methodological literature on the discipline “Biomechanics”](image)

The content of the developed resource includes educational and methodological information that will allow the student to master practical skills and abilities, to use the theory and methods of biomechanical measurement, biomechanical analysis and didactics of motor activity in physical education and sports training.

The e-mail addresses of the Department of Informatics and Biomechanics lecturers, which teach this subject on the course (for additional consultations, verification of the correctness of the design abstracts and the resolution of organizational issues) are indicated. This form of communication has become relevant, as students may not always consult with lecturers directly for a number of reasons (departure for sports events, frequent trainings, weekends, illness etc.).

Practical learning of the discipline “Biomechanics” by students with using a computer laboratory workshop suggests that the acquired knowledge will provide the opportunity to teach movements with the using of basic biomechanical positions, to improve motor programs, to promote health and safety in the process of physical culture activity in school, when performing sports coaching and physical rehabilitation of patients and athletes.

**C. Computer Workshop on Biomechanics**

In order to increase the mastering level of kinesiological competence of future specialists in physical culture and sports at the Department of Informatics and Biomechanics of Kharkiv State Academy of Physical Culture a computer workshop on the discipline "Biomechanics" has been created.
The technical side of the problem implies the specification of the type of activity that should be modeled. It can be a competitive activity of the best athletes (a natural model), a description of the simulated process in the form of mathematical formulas etc. In addition, it is necessary to determine the components of the model and the parameters and variables with corresponding functional relations; evaluation of the adequacy of the selected analogue and modeled type of motor activity; development of a computer simulation model of the motor activity type. The collection of output data can be performed through physical, functional and technical tests, the results of pedagogical observations of competitive activities, etc.; directly computer simulation of the motor activity type; adjusting the type of activity by the results of computer simulation.

This workshop was developed in Borland Delphi 7 using Pascal programming language. The main menu contains the user registration form and the list of laboratory works (Fig. 3).

![Fig. 3. The main window of the computer workshop on Biomechanics](image)

Theoretical information concerning the selected work appears in the main window after selecting the laboratory work. The "registration" field should be filled before the beginning of work (Fig. 4).

![Fig. 4. A window with theoretical knowledge concerning selected laboratory work](image)

Moreover, by clicking the button "Practical classes" the window with electronic tables and graphic elements related to the selected work is displayed (Fig. 5). When processing these data, the user calculates and inserts the data in the table.

![Fig. 5. Worksheet windows](image)

A measuring complex of movements’ parameters, based on the use of a stroboscopic effect allows you to measure the distance to the object in the range of 3-110 m and instantaneous speed of movements; to display information on the monitor and print it; to form a database of results of motor activity analysis.

Besides, after clicking the "Save Data" button, the computer processes the information being entered and it builds a graphic that visually reproduces the results of calculations made by the user in the table. To implement the graphic part, Pascal methods, classes and procedures, such as Canvas and StringGrid, were used.

Since the calculation of all entered data in the software is done automatically, the user needs only to enter the required data and to go to the window with a table on the tab “Graph”, where the software builds the coordinate system and graphs of studied values, depending on the indicators in the table. As a result of the performed laboratory work, the software analyzes the performed calculations and evaluates the user’s work.

After entering data and processing, the user saves the performed laboratory work using the "Save Data" button. When you click on it, the software will offer to select the path for storage on the hard disk or portable storage. The saved file stores the following data: the calculations entered into the table, the functions graph, the user name and group number.

The presence of tests, which are distributed on the main themes of the discipline “Biomechanics”, is important for monitoring of self-training (Fig. 6). Students can examine questions and prepare for the exam independently.

It can be said that the computer laboratory workshop on Biomechanics contains elements of the expert system, because it is partially capable to replace a specialist in the field of biomechanics. Each laboratory has its own graphical interface and a complex internal system of programming formulas for data computation and their graphical representation.
The software Biomechanics forms students' kinesiological competence that makes it possible to analyze kinematics and dynamics of motor actions based on data of objective registration of physical exercises; to quantify the biomechanical characteristics of the human body and its motor activity; to quantify the level of development of basic motor qualities; to model biomechanical characteristics of individual rational technique and tactics of motor activity; to use modern biomechanical technologies for quantitative control, evaluation and training (correction) of motor actions.

The developed complex can also be effectively used for studying new motor actions (movement techniques) and improving motor actions mastered during practical training of future specialists in physical education and sports. It can also be used in the process of training activities in the sport of higher achievements.

REFERENCES


