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USE OF SECTRA VIRTUAL DISSECTION TABLE IN THE EDUCATIONAL PROCESS

Abstract. The article features the research of the effectiveness of using the virtual dissection table in medical higher educational institutions. The theoretical and methodological foundations of the use of the virtual dissection table in the training of future medical specialists are determined, practical aspects are described. Laboratory works have been created on the use of the virtual dissection table in teaching theoretical and clinical disciplines in medical higher education institutions. The authors considered the formation of the following components of students' experimental competence through the use of Sectra Virtual Dissection Table during the lessons: cognitive-intellectual, diagnostic, prognostic, information, analytical and research. The cross-curricular links between the disciplines "Human Anatomy" and "Medical and Biological Physics" in view of the formation of the aforementioned experimental competences are considered. The algorithm for work with the muscular system in the Human Anatomy Atlas program on the Sectra Table F18 Virtual Dissection Table is described in detail. The authors showed the capabilities of the Sectra Virtual Dissection Table: viewing realistic human anatomy; simulation of the human body in combination with 3D touch control when viewing, panning, rotating and zooming in an image; distance measurement in 3D volume and arbitrary clipping plane; cropping a part of 3D volume etc. The authors point out that the use of a virtual anatomical table should take into account students' and teachers' information and digital competence to work with modern virtual equipment and the educational environment of the medical educational institution. Extended clinical cases with unique pathologies in the Sectra Table library contribute to the formation of medical students' professional competencies. The authors conclude that the use of medical computer programs allows the teacher to organize innovative types of educational activities and to form students' experimental competence components. The prospects for further research might involve conducting a pedagogical experiment on the effectiveness of using the created system of laboratory works and demonstrations on the basis of Sectra Table F18 Virtual Dissection Table.

Keywords: experimental competences; information and communication technologies; virtual dissection table; institutions of higher medical education; muscular system model.

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1. INTRODUCTION

Statement of the problem. Modern trends in the transformation of the content of medical education, according to the Strategy for the Development of Medical Education in Ukraine [1] in the context of fundamental changes in the selection, training and professional development of Ukrainian doctors, actualize the search for new approaches to training.

Learning environments based on computer-based tools and learning systems, provided they are connected to the Internet, help to increase the efficiency and improve the educational process in higher medical education institutions. Such learning environments make it possible to implement remote forms of learning activity, which are characterized by access to unlimited information resources, a great opportunity for the implementation of personality-oriented education. The issue of distance education became especially relevant after the announcement of a long quarantine in educational institutions in connection with the active spread of the new infectious disease Covid-19.

The main task facing the teachers of the Donetsk National Medical University was the introduction of a distance education system with the provision of a favorable influence of new technologies on the educational process. Purposeful and controlled intensive independent work of a student who can study in a place convenient for them, having a set of special teaching aids and an agreed opportunity to contact a teacher, have increased the quality of student learning.

Educational activities of students effectively organized by teachers in a virtual educational space using modern information technologies have become a necessary and accessible tool for medical research and in clinical practice [2-5]. The formation of information and digital competence among future Masters of medicine (MMED), in the context of the rapid development of the information society, ensures the release of highly qualified and competitive doctors in the labor market.

Analysis of recent research and publications.

The use of information and communication technologies is the subject of many scientific studies, presented in the works of A. Iatsyshyn, O. Bashmakov, V. Bykov, N. Bezrukova, A. Zviahina, I. Bohdanov, S. Velychko, N. Soroko, N. Homulina, M. Zhaldak, Yu. Zhuk, V. Zabolotnyi, O. Ivanytskyi, A. Silveistr, O. Sokolyuk, O. Skliarova, etc. The experience of introducing the latest information technologies in medical education is described in the works of C. Nwozichi, D. Marcial, A. Farotimi, A. Escabarte, A. Madu, L. Sukhovirska, O. Lunhol, O. Zadorozhna, H. Han, D. Resch, R. Kovach and others [6-8].

Based on the work of the aforementioned scholars, we have highlighted a number of benefits that educational ICTs provide for medical students:

1) stimulation and development of mental cognitive processes: attention, logical and algorithmic type of thinking (due to the interactivity of educational software and students' ability to independently manage the educational process); sensations – visual and auditory sensitivity; perception, imagination, memory (through the use of dynamic circuits, animations of models of physical phenomena and biomedical processes, as well as idealized material objects);

2) increasing the interest and motivation for studying such disciplines as Human Anatomy, Medical and Biological Physics, Physiology, Surgery, etc.;

3) the development of experimental research skills (through the use of computer biomedical models, demonstrations, experiments, medical model tasks);

4) activation of independent thinking due to computer visualization of educational information; self-learning due to the theoretical assimilation of concepts and patterns; development of skills in solving medical problems, self-control through appropriate testing programs and self-correction.

For the teaching staff of higher medical education institutions, active use of ICT in teaching theoretical and clinical disciplines provides the following opportunities:

1) individualization and differentiation of teaching;

2) intensification of the educational process through fast and convenient access to information about the objects of study;

3) increasing the effectiveness and quality of explaining the material in theoretical and clinical disciplines, in particular due to visualization;

4) expansion and improvement of medical-biological and physical demonstration, enhancement of the experiments quality based on the use of a computer system and modern laboratory equipment; automation in the processing of experiment results and control of laboratory equipment; display of numerical data of the system physical parameters and real-time graphical interpretation (data logging);

5) automation of knowledge quality control in theoretical disciplines using computer testing;

6) increase in motivation, psychological and pedagogical efficiency of teaching natural sciences due to new forms of work;

7) implementation of new methodological systems that improve teaching methods and forms of educational process organization, in particular, provide the opportunity to develop original projects of laboratory work or demonstration experiments [7, p. 143];

8) reduction of material and time expenses for the organization, preparation and conducting of training sessions.

The virtual anatomical table as a kind of modern ICT is being actively introduced into the educational process of institutions of higher medical education. Of considerable interest are the works of foreign scientists devoted to the study of medical education content modernization by means of ICTs through introduction of interactive virtual dissection tables in the educational process of institutions of higher medical education. Thus, G. Macchiarelli, S. Bernardi, M. Continenza, J. Di Biasi, M. Palmerini, S. Bianchi describe in their work [9] the Anatomage and Sectra tables as advanced anatomy visualization systems, adopted by many of the world's leading medical schools and institutions. They describe experience and results of work with Anatomage during the Academic Year 2016-17 in the Postgraduate Courses of Medical and Surgical Specialization and Basic Degrees in Nursing and Biotechnology of the University of L'Aquila. A. Todorov, D. Marinova, S. Trifonov, S. Doseva, S. Yochkova, R. Dotsova, I. Gerasimov, T. Rashev, E. Ivanov [10] evaluated students` opinion on an innovative interactive method provided by the virtual dissection table Sectra in dissection practice. During the second semester of practical training in cadaver dissection cycle, students realized a pilot practical exercise using Sectra Virtual Dissection Table. Most of the students pointed out that combining the two methods – virtual and real – would be the best way to help them understand the information. The authors emphasized that Sectra table gives the unique opportunity to provide basic knowledge of the body, adding more opportunities to the classical method [10]. K. Darras, S. Nicolaou, P. Munk [11] note that virtual dissection offers a more efficient means of learning anatomy in a time-constrained curriculum, offering new educational luxuries, such as faster dissection, as well as the ability to dissect different systems simultaneously and correct dissection mistakes. In [11, p. 233], scientists express their views on the importance of the virtual dissection, because it represents a fundamental change for both the anatomy lab and the radiologist's role in medical undergraduate teaching, it invites radiologists to enter the gross anatomy lab and become digital anatomists, blending expertise in data reconstruction with knowledge of clinical anatomy.

The study of the effectiveness of virtual dissection tables in the academic process has been carried out by K. Darras, R. Spouge, R. Hatala, S. Nicolaou, J. Hu, A. Worthington, C.

Krebs, B. Forster [12 – 13], who, as a result of a pedagogical experiment, found out that students' learning was enhanced when virtual dissection was combined with a cadaver-based anatomy laboratory. German scientists D. Paech, F. Giese, R. Unterhinninghofen, H.-P. Schlemmer, T. Kuner, S. Doll describe their experience of using virtual dissection tables: students provided with cadaver CT scans achieved 27 % higher scores in anatomy; radiological education integrated into gross anatomy is highly appreciated by medical students; simultaneous physical and virtual dissection provides unique conditions to research anatomy.

Based on the analysis of the recent research, we have come to the conclusion that the introduction of virtual dissection tables is relevant and actively researched by foreign scientists. However, there are very few scientific works of domestic scientists on the introduction of virtual dissection tables in the educational process of Ukrainian institutions of higher medical education [14–15]. Therefore, **the aim of the article** is to consider theoretical and methodological foundations of using Sectra Virtual Dissection Table for teaching medical students on the example of its practical implementation in the courses "Human Anatomy" and "Medical and Biological Physics".

2. RESEARCH METHODS

To achieve the goal of the article, we used the following complex of research methods: a) theoretical – analysis of psychological, pedagogical, methodological and medical literature (comparison and juxtaposition of different views on the problem of the formation of experimental competencies, defining theoretical and methodological foundations of using the virtual dissection table in the training of future health professionals); synthesis (practical aspects are defined and a complex of practical assignments on the use of dissection table in teaching the courses "Human Anatomy" and "Medical and Biological Physics" was developed; the specificity of students' work with the Sectra Dissection Table was investigated); b) empirical – observation, survey (questioning, testing*)* to determine the effectiveness of the developed complex of practical assignments aimed at the assessment of the level of students' experimental competence.

3. RESEARCH RESULTS

In early 2019, Donetsk National Medical University acquired a Sectra Virtual Dissection Table model F18. Teachers of theoretical departments, with the support of information technology scientists from other universities, began active work on introducing the anatomical table into the educational process of the international medical faculty and medical faculty No. 2 in Kropyvnytskyi.

The study of the human body structure by students of medical schools is the basis for the formation of a correct understanding of how organs work and for the correct diagnosis of the patient's condition. However, the use of corpse material in the educational process of institutions of higher medical education has been reduced [16]. Traditional methods of studying anatomy at the present stage of medical education require improvement. So, the use of interactive learning technologies provides an opportunity for a more comprehensive and effective study of human anatomy [1-4]. Working with virtual anatomical material gives the possibility to evaluate the topography of the organ, its blood supply and innervation, facilitates the perception of a large amount of information contained in the textbook. Students have the opportunity to consider in 3D projection the location of the organ, vessel or nerve, to trace its direction and relation to neighboring organs. There is also an option of layer-by-layer

tissue removal, followed by an examination of the deep layers of the body [16]. Students can also practice virtual dissection techniques. The table can be used for students' independent work as a self-control program, which includes description of parts, formations and whole organs [16].

As a result, the developed system of laboratory works contributes to the formation of the following components of students' experimental competence:

cognitive-intellectual, as a combination of theoretical knowledge and practical skills in staging demonstrations;

diagnostic, as a student's ability to self-assess their own ability to design experiments and perform laboratory or practical work aimed at confirming theoretical knowledge of a particular discipline;

prognostic, as the ability of students to determine the goals and significance of their activity at each stage of the presentation or performance of experiments, laboratory or practical work, to predict the final result***;***

information, which is the main source of scientific and educational information***;***

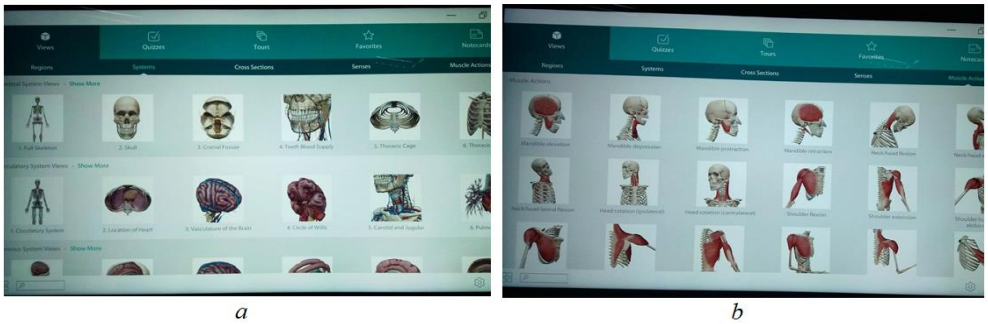
analytical, as the ability to analyze the results of experiments, laboratory and practical work***;***

research, which involves the ability to observe and analyze each stage of the experiment, put forward hypotheses for each stage of the experimental activity, analyze information sources, master scientific thinking.

Let us consider the cross-curricular links between the disciplines "Human Anatomy" and "Medical and Biological Physics", namely, examples of practical tasks for the formation of the above-mentioned experimental competencies using the Sectra Virtual Dissection Table model F18.

During the study of the content module "Human muscular system" of the discipline "Human Anatomy" the muscular system is studied as an active part of the musculoskeletal system. Students also consider in detail age peculiarities of the muscular system, muscles of the head and neck, trunk, upper and lower limbs.

The study of this topic is carried out using the Sectra Virtual Dissection Table model F18 with Human Anatomy Atlas software installed. It includes the anatomical atlas of male and female organisms sorted by departments and systems (Fig. 1 a). Students can study the structure of muscle as an organ, classification, topography and function of muscles, muscle work, etc. Students can work with models and perform the following actions: rotate, tilt, zoom in, hide, and change clarity to study at any angle any number of anatomical formations in viewing mode, fuzzy display or in a hidden form (Fig. 1 b).



a *b*

Fig. 1. Structural sections of the program "Human Anatomy Atlas 2017 Edition"

Knowledge of this topic is the basis for further research on the presence, localization and course of pathological processes, the provision of therapeutic and surgical care. This

knowledge is necessary for the study of Anatomy (innervation, blood supply), Medical and Biological Physics, Histology, Physiology, Anatomical pathology, Pathophysiology, Surgery, and other disciplines.

The algorithm of work in the Human Anatomy Atlas program is as follows:

– the file is launched by opening the program through a shortcut on the desktop: "Human Anatomy Atlas 2017 Edition" or along the way: C:\ProgramFiles (x86)\ VisibleBody\ Human Anatomy Atlas 2017 Edition;
– after opening the file "Human Anatomy Atlas 2017 Edition", the working window offers the user the following functions: Views, Quizzes, Tours, Favorites, Notecards;
– function Views offers access to the following tabs:

1 Regions, which contains Regional Views: Head and Neck, Thorax, Abdomen, Cubital Fossa etc.
2 Systems, which includes a 3D anatomical atlas of male and female organisms sorted by departments and systems: Skeletal System Views, Circulatory System Views, Nervous System Views, Respiratory System Views, Muscular System Views, Digestive System Views, Urinary System Views, Lymphatic System Views, Endocrine System Views, Reproductive System Views.
3 CrossSections with the following sections: Head (Axial), Head (Coronal), Head (Sagittal), Thorax (Axial), Abdomen (Axial), Pelvis (Axial).
4 Senses (Ear, Middle Ear, Inner Ear, Tongue Section, Eye, Touch Reception, Hair Follicle).
5 The Muscle Actions tab, which includes the following animations: Neck/head lateral flexion, Spine lateral flexion, Elbow flexion, Mandible retraction, Shoulder extension, Shoulder horizontal abduction etc.

Detailed information on the structure, location and functioning of muscles is contained in the Regions, Systems and Muscle Actions tabs. After choosing an anatomical formation, a student clicks on the necessary structural element to display its name and anatomical hierarchy to which it belongs (Fig. 2 a).

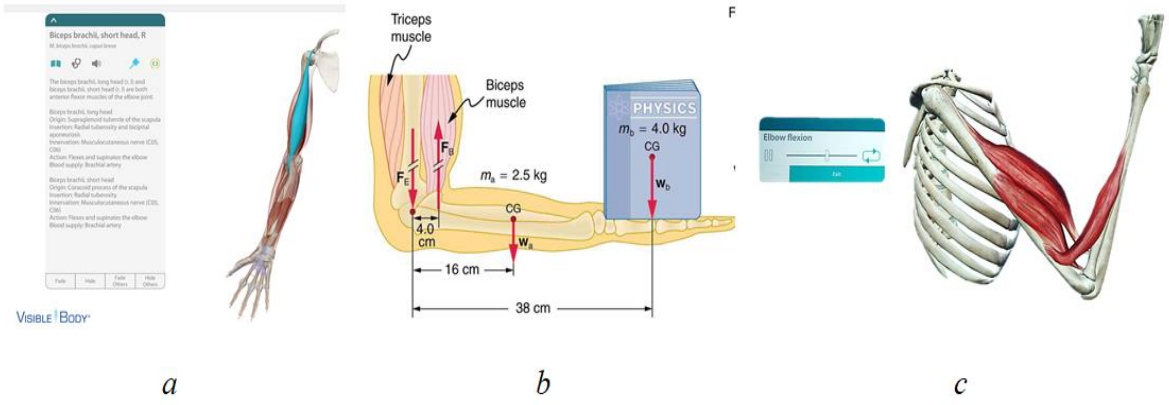


Fig. 2. Work with the program "Human Anatomy Atlas 2017 Edition"

The complex of laboratory works on the theme "Human muscular system" in the program Human Anatomy Atlas for the discipline "Human Anatomy" includes 4 virtual laboratory works: "Head and neck muscles"; "The muscles of the torso. Respiratory muscles"; "Upper limb muscles"; "Lower limb muscles". Working with this complex allows students to form the following components of experimental competence: determine and show the beginning and attachment of muscles according to their topography and development, specify the function of each muscle, etc.

Let's consider the cross-curricular connection of the topic "Muscular system" in the discipline "Human Anatomy" with the topic "Fundamentals of biomechanics" of the discipline "Medical and Biological Physics".

Implementation of cross-curricular relationships with the formation of practical skills in the process of solving problems in "Fundamentals of Biomechanics" is carried out using a Sectra Virtual Dissection Table model F18 with "Human Anatomy Atlas 2017 Edition" software.

Let's analyze a sample task for students:

1. Solve a typical problem in biomechanics [17], for example: Calculate the force the biceps muscle must exert to hold the forearm and its load as shown in the figure, and compare this force with the weight of the forearm plus its load. You may take the data in the figure to be accurate to three significant figures (Fig. 2. b).
2. Using the Sectra Virtual Dissection Table model F18 with "Human Anatomy Atlas 2017 Edition" software, move on to individual solutions and complicate the task:
   a. First, it is necessary to analyze what muscles are involved in the system. Then find them in the program "Human Anatomy Atlas 2017 Edition" and make a detailed description using the help system of the program;
   b. Open the tab Muscle Actions (Human Anatomy Atlas – Views – Muscle Actions);
   c. Open the appropriate animation, in our case “Elbow flexion” (Fig. 2. c);
   d. Take a screenshot at any point in the animation with the appropriate button at the bottom of the monitor. By default, the photo is saved in the folder: C:\Users\Zver\Pictures\VisibleBody\ Human Anatomy Atlas.
   e. Forward the photo for printing. If there is a printer connected, directly print the resulting image.
   f. Next, change the values of physical quantities with a predetermined step according to the student’s variant or limit the values in a certain range, providing students with the possibility of independent choice.
   g. Note down all quantities according to the task. Indicate on the printed figure all the forces acting on the system.
   h. Students solve a self-created task using a Sectra Virtual Dissection Table model F18.
   i. Analyze the results obtained and compare them with a typical task.

Work with the Virtual Dissection Table can be expanded to other disciplines.

Radiology training. Sectra Table is compatible with all imaging modalities, enabling teachers and students to easily download suitable educational references. In addition, they have access to the same tools radiologists use in their clinical environment.

Histology training. Sectra Table supports a new pathology viewer. This function can be actively used both in the learning process, and directly in the medical institution for the diagnosis of patients or operations because users can import histology images with different staining and link them to the patient’s CT or MR scan. This combination allows students to first view a patient’s anatomy and then zoom in and study the pathological changes at the tissue level.

Orthopaedic/Surgical training. Sectra Table provides an optional add-on for 3D preoperative planning. These tools allow users to interactively evaluate and discuss different cases and strategies, making the table ideal for surgical training.

Veterinary medicine. Sectra Table brings in imaging data from any species. Combined with the ability to share data for all veterinary specialties, this solution is well suited to training in the veterinary sciences. Access to three-dimensional views of tendons, muscles and ligaments facilitates teaching of sports-related soft tissue injuries and supports discussion and

communication around treatment strategies with individuals suffering from these and other conditions [18].

Thus, the use of Virtual Dissection Table in the educational process allows the teacher to organize innovative types of educational activities, to develop various components of students' experimental competence: cognitive-intellectual, diagnostic, prognostic, information, analytical and research. A wide range of training programs adapted for Virtual Dissection Table allows teachers not only to improve the visibility of the training material, but also to form various types of training tasks in search, calculation, reproduction, etc.

4. CONCLUSIONS AND PROSPECTS OF FURTHER STUDIES

Sectra Table is a multi-touch screen for interactive learning and teaching. It comes with an anatomy atlas and model cases (a number of pre-prepared clinical cases based on medical images). Users can easily add their own cases. Sectra's offering also includes a workspace for advanced preparation and organization of cases.

Sectra Table facilitates problem-based learning and can be utilized in a range of medical programs, such as Anatomy, Medical and Biological Physics, Medical Informatics, Radiology, Orthopedic Surgery, Veterinary Medicine, Sports Medicine etc.

The use of a Virtual Dissection Table should take into account students' and teachers' information and digital competence, their ability to work with modern virtual equipment and the educational environment of the medical educational institution. This interaction should take place in spatial, temporal, informational and energy aspects.

When you interact with virtual representations of real-life bodies based on clinical imaging, you get a deeper understanding and insight into anatomy, as well as the functions and processes inside the body.

Sectra Table software provides a clear image for viewing realistic human anatomy. Simulation of the human body in combination with touch control in 3D mode provides the ability to view, pan, rotate, zoom in, add comments, measure distance in a 3D volume, an arbitrary cutoff plane, crop part of a 3D volume, etc. As a result, accurate digital information based on the corpse of a real person, rich content and a set of functions attract students' interest and attention, provide more effective learning outcomes; realistic structures improve students' spatial thinking in understanding the human body. Additional clinical cases with unique pathologies in the Sectra Table library contribute to the formation of medical students' professional competencies. Students have the opportunity to quickly dissect, increase and decrease anatomical zone in layers, compare, thereby focusing on those points that interest them.

The prospects for further research include conducting a pedagogical experiment on the effectiveness of using the complex of laboratory works and demonstrations that we developed on the basis of Sectra Virtual Dissection Table model F18.

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ВИКОРИСТАННЯ ВІРТУАЛЬНОГО АНАТОМІЧНОГО СТОЛУ SECTRA В ОСВІТНЬОМУ ПРОЦЕСІ

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Анотація. Стаття присвячена дослідженню ефективності використання віртуального анатомічного столу в освітньому процесі закладів вищої освіти. Визначено теоретико-методичні засади використання анатомічного столу в професійній підготовці майбутніх медичних фахівців, описано практичні аспекти, і, як результат, розроблено комплекс робіт з використання анатомічного столу у викладанні теоретичних та клінічніх дисциплін у закладах вищої медичної освіти. Авторами розглянуто формування у студентів наступних компонент експериментальної компетентності шляхом використання віртуального анатомічного столу Sectra на заняттях: пізнавально-інтелектуальної, діагностичної, прогностичної, інформаційної та аналітичної. Розглянуто міжпредметні зв'язки між дисциплінами «Анатомія людини» й «Медична та біологічна фізика» з формуванням вищезазначених експериментальних компетентностей. Детально описано алгоритм роботи в програмі «Human Anatomy Atlas» на віртуальному анатомічному столі SECTRA Table F18 з моделлю м'язової системи. Авторами показано можливості віртуального анатомічного столу SECTRA з перегляду реалістичної анатомії людини, симуляції тіла людини в поєднанні з сенсорним керуванням у режимі 3D при перегляді, панорамуванні, обертанні, наближенні зображення, вимірюванні відстані в 3D об'ємі, довільній площині відсічення, через обрізання частини 3D об'єму тощо. Автори статті зазначають, що використання віртуального анатомічного столу необхідно проводити з урахуванням інформаційно-цифрової компетентності студентів та викладачів при роботі з сучасним віртуальним обладнанням в освітньому середовищі медичного навчального закладу. Розширені клінічні випадки з унікальними патологіями в бібліотеці Sectra Table сприяють формуванню у студентів-медиків фахових компетентностей. Автори роблять висновок, що використання медичних комп'ютерних програм дозволяє викладачу організувати інноваційні види навчальної діяльності та формувати у студентів компоненти експериментальної компетентності. Перспективи подальших досліджень полягають у проведенні педагогічного експерименту з ефективності використання розробленого комплексу лабораторних робіт та демонстрацій на базі анатомічного інтерактивного столу SECTRA Table F18.

Ключові слова: експериментальні компетентності; інформаційно-комунікаційні технології; віртуальний анатомічний стіл; заклади вищої медичної освіти; модель м'язової системи.

ИСПОЛЬЗОВАНИЕ ВИРТУАЛЬНОГО АНАТОМИЧЕСКОГО СТОЛА SECTRA В ОБРАЗОВАТЕЛЬНОМ ПРОЦЕССЕ

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Аннотация. Статья посвящена исследованию эффективности использования виртуального анатомического стола в образовательном процессе высших учебных заведений. Определены теоретико-методические основы использования анатомического стола в профессиональной подготовке будущих медицинских специалистов, рассмотрены практические аспекты и разработан комплекс работ по использованию анатомического стола в преподавании теоретических и клинических дисциплин в учреждениях высшего медицинского образования. Авторами рассмотрено формирование у студентов при использовании виртуального анатомического стола на занятиях следующих компонент экспериментальной компетентности: познавательно-интеллектуальной, диагностической, прогностической, информационной и аналитической. Рассмотрены межпредметные связи между дисциплинами «Анатомия человека» и «Медицинская и биологическая физика» с формированием вышеупомянутых экспериментальных компетенций. Подробно описан алгоритм работы в программе Human Anatomy Atlas на виртуальном анатомическом столе SECTRA Table F18 с моделью мышечной системи. Авторами показано возможности виртуального анатомического стола SECTRA по изучению реалистической анатомии человека, симуляции тела человека в сочетании с сенсорным управлением в режиме 3D при просмотре, панорамировании, вращении, приближении изображения, измерении расстояния в 3D объеме, произвольной плоскости отсечки, через обрезание части 3D объема и тому подобное. Авторы статьи отмечают, что использование виртуального анатомического стола необходимо проводить с учетом информационно-цифровой компетентности студентов и преподавателей при работе с современным виртуальным оборудованием в образовательной среде медицинского учебного заведения. Расширенные клинические случаи с уникальными патологиями в библиотеке Sectra Table способствуют формированию у студентов-медиков профессиональных компетенций. Авторы делают вывод, что использование медицинских компьютерных программ позволяет преподавателю организовать инновационные виды учебной деятельности и формировать у студентов компоненты экспериментальной компетентности. Перспективы дальнейших исследований заключаются в проведении педагогического эксперимента по эффективности использования разработанного комплекса лабораторных работ и демонстраций на базе анатомического интерактивного стола SECTRA Table F18.

Ключевые слова: экспериментальные компетентности; информационно-коммуникационные технологии; виртуальный анатомический стол; учреждения высшего медицинского образования; модель мышечной системы.

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