

COMBINATION OF NEW, INNOVATIVE AND DEMONSTRATIVE 3D ELEMENTS WITH CLASSICAL LEARNING METHODS IN HUMAN ANATOMY COURSE

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Abstract

The aim of this work was to study, compare and summarize our experience in combination of innovative and demonstrative 3D elements with classical learning methods in Human Anatomy course. In practical classes 100 students of the 1st study year of the Faculty of Medicine used the virtual dissection Anatomage Table and/or their own prepared anatomical models by 3D printer. 100 students of the 2nd study year used the classical human cadaveric dissections. All participants were asked to discuss about these used teaching methods and complete an anonymous feedback questionnaire. 70% of students were satisfied with the virtual dissection and/or their own prepared anatomical 3D models in group 1, but they liked to highlight the role and necessity of real dissection. Some students were satisfied with the classical learning and teaching of human anatomy when associated it with the use of different 3D elements. 90% of students considered that virtual elements and models were useful in learning the study course outside the practical classes. In group 2 more than 95% of participants indicated that dissections should be regular. There classical learning of anatomical structures obtained better results than only in the innovations supported group. In human anatomy 3D elements together with classical learning methods can motivate students to study the morphological disciplines, increase their interest and the effectiveness of studies.

Keywords: *human Anatomy, dissection, students, virtual learning*

1. INTRODUCTION

It is known the fact that human anatomy has an important role in the medical and health education (Ocak & Topal 2015). Therefore, anatomy is one of the main basic study courses and there exists a close relationship between it and clinical courses and practice (Ngan et al. 2018). Technologies and current innovations created in the last years have stimulated a discussion and questions about the role of combination of methods as a teaching tool and learning of anatomy in new context (Azer & Azer 2016). The study by Buckenmeyer et al. (2016) showed that technology-enhanced courses managed better activities, increased communication with instructors and expanded opportunities for practice. Yammine (2014) underlined that the integration of modern and traditional methods is one of the actual challenges of the anatomy teaching in a modern curriculum. Trelease (2016) explained that digital possibilities and technologies offered development of numerous educational resources for anatomical sciences education. In today's society different mobile technologies and devices potentially deliver education and help to explain basic concepts (Gunčaga, Koreňová & Kostrub 2018). On the other hand, according to the changes to the medical program's curriculum, McBride and Drake (2018) reported that in some parts of the anatomical sciences decreased the average numbers of contact hours. The time for teaching and learning anatomy must be effectively deployed in the optimal environment and it is very important the understanding of how students learn anatomy (Smith, Martinez-Álvarez & Mchanwell 2014). Dissection experience is important for learning and understanding of the anatomical structures and relationships between them (Border 2017). Some authors evaluated and reported the role of imaging that enhanced the quality and efficiency of instruction in teaching human anatomy (Grignon, Oldrini & Walter 2016). In our modern era and medical studies 3D printing is a rapidly expanding technology. McMenamin et al. (2014) found that it as one of the most promoted significant technological advances for teaching of topographic and clinical anatomy. Yilmaz et al. (2015) mentioned that new visual materials together with three-dimensional (3D) anatomy models are increasingly being used in anatomy education. Modern technologies and speed of their development

lead to the changes of learning process for students in morphological disciplines. In medical education combinations of new, innovative and demonstrative 3D elements complement the classical, traditional methods and create opportunities for students and tutors to learn new experiences. In addition, the role of dissections continues to be important for students in Human Anatomy course. The aim of this work was to study, compare and summarize our experience in combination of innovative and demonstrative 3D elements with classical learning methods in Human Anatomy course.

2. MATERIALS AND METHODS

2.1. Materials

In this study were included 100 students of the 1st study year (group 1) and 100 students of the 2nd study year (group 2) of the Faculty of Medicine, Rīga Stradiņš University, in the academic year 2018/2019. In practical classes the first group of students was asked by tutors to use the virtual dissection Anatomage Table (Table Application software from Anatomage, Inc. (Table EDU 4.0), USA) and/or their own prepared anatomical models by “Prusa i3 MK2” 3D printer without any dissections. The second group of students used the classical human cadaveric dissections without any technological resources. Tutors were present together with students, especially for their areas of help or expertise. All students were informed of the aims of this study, and their involvement was voluntary.

2.2. Methods

At the beginning of each practical class, students received instructions from tutors in 3D virtual and real dissections, and/or 3D model preparing, printing and post-processing processes. 1 hour students worked from special anatomical structures lists that included different regions of the body. At the end of the practical classes, students of both groups were tested by tutors and assessed by practical questions involving the identification and description of 10 structures. Groups 1 and 2 were compared according to the study process results. All participants were asked to discuss about these used teaching methods and complete an anonymous feedback questionnaire about study course in e-studies at the end of semesters. In discussions the questions were asked to identify different aspects of every teaching method and overall satisfaction of the students with the method. The effect level evaluations of satisfaction were graded by the following expressions: “1= Like”, “2= Dislike” and “3= Necessary”.

3. RESULTS

In both groups the students were asked whether or not they liked the virtual dissection Anatomage Table, their own prepared and printed 3D anatomical models, and dissection (Table 1).

Table 1. Comparison of satisfaction of students according to teaching methods in group 1

Teaching method	n=100		
	Like (%)	Dislike (%)	Necessary (%)
Virtual dissection Anatomage Table	45.25	4.40	18.86
3D anatomical models	24.75	0.15	6.59
Virtual dissection Anatomage Table + 3D anatomical models	70.00	4.55	25.45
Dissection (was not used)	-	-	99.50

n = number of students; 3D - three dimensional

In learning of structures 70% of the students were satisfied with the virtual dissection and/or their own prepared anatomical 3D models in group 1, but they liked to highlight the role and necessity of real

dissection. Use of only virtual dissection Anatomage Table was thought to be enough to teach and study anatomy by 45.25% students, while 24.75% students said that they liked more anatomy with prepared and printed 3D anatomical models. Some students remarked that they were satisfied with the classical learning and teaching of Human Anatomy course when associated it with the use of different new, innovative and demonstrative 3D elements. Majority of students (90%) considered that virtual elements and models were useful in learning the study course outside the practical classes.

In group 2 more than 95% of participants indicated that dissection anatomy should be regular and available to all students (Table 2).

Table 2. Comparison of satisfaction according to advantages of dissection method in group 2

Advantages of dissection method	n=100		
	Like (%)	Dislike (%)	Necessary (%)
Touch of real body	98.35	1.65	96.34
Use of surgical instruments	87.83	12.17	88.26
3D view of stuctures and body parts	79.66	20.34	90.67
Better level of anatomical knowledge and results	93.72	6.28	89.11
Better understanding of clinical and surgical cases	81.76	18.24	92.45
Team work	75.48	24.55	84.67
Regular/available tool for anatomy learning and teaching	83.27	16.73	95.45
Necessary to become specialists in medicine	97.14	2.86	96.23

n = number of students; 3D - three dimensional

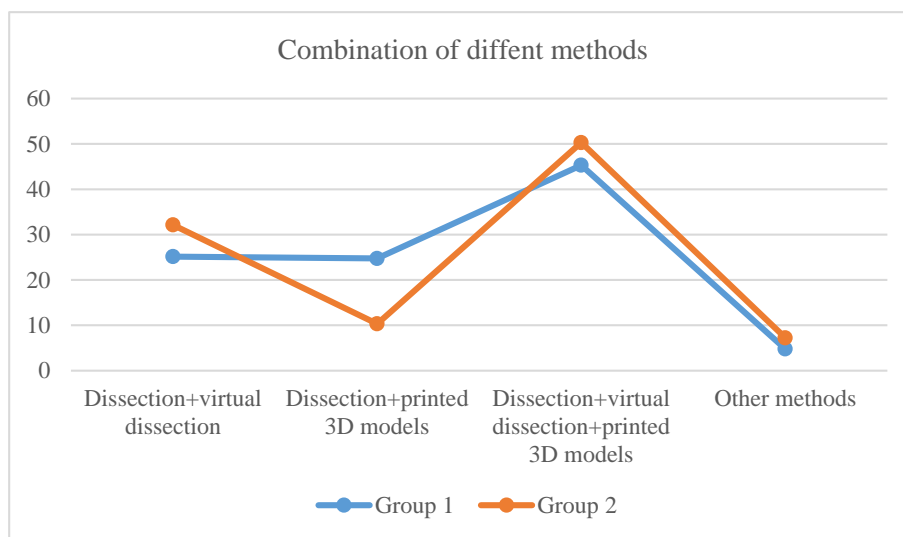


Fig. 1. Necessity of combination of different methods in anatomy course in both students groups

Almost all students mentioned that dissections provided the real touch feeling of human body. In group 2 classical learning of anatomical structures obtained better results than only in the innovations supported group. When asked about necessity of advantages of dissection method, 96.23% of students indicated that it is necessary to become specialists in medicine, while 92.45% students marked that it is important for better understanding of clinical and surgical cases.

Regarding possible combinations of methods in teaching and learning anatomy in both groups, all students were asked about different variants of used methods as well as other methods (computer-aided learning, plastinates, CT scans, imaging techniques). In both groups the large number of students gave preference to combination of real and virtual dissection, and printed 3D models (Fig. 1). In group 2 this combination was marked by 50.31% students, while in group 1 it was appreciated by 45.31% students. The need for increasing only real and virtual dissection methods was indicated by 32.14% students in group 2, while the need for dissection and printed 3D models combination was preferred by 24.75% students in group 1. Regarding possible combination with other methods in Human Anatomy course, only 4.78% students and 7.23% students mentioned them in group 1 and group 2.

Table 3. Discussion between students about necessity of other methods for Human Anatomy course

Other method	n=200
	Necessary (%)
Computer-aided learning	20.45
Use of plastinates	23.67
Use of CT scans	25.80
Use of imaging techniques	30.08

n = number of students

When asked about other methods or improvements for methods in Human Anatomy course (Table 3), students of both groups gave preference to the use of imaging techniques (radiological anatomy) and the use of CT scans (30.08% and 25.80%). Only 20.45% of students mentioned the use of computer-aided learning. 20.45% of students indicated the use of plastinates.

Table 4. Student`s perception of acquiring anatomical knowledge using different methods

Teaching method	n=200		
	Better level of knowledge (%)	Motivation of learning (%)	Identification and understanding (%)
Classical dissection	60.76	74.55	55.38
Virtual dissection	25.23	14.33	20.45
Prepared and printed anatomical models	14.01	11.12	24.17
Total	100%	100%	100%

n = number of students

Comparison of students` perception scores of acquiring anatomical knowledge, using different learning methods in Human Anatomy course, demonstrated that classical method (dissection) was the best method for better level of knowledge, motivation of learning, identification of anatomical structures and their understanding (Table 4). New innovations (virtual dissection and printed models) helped 44.62% students for identification and understanding of anatomical structures. 39.24% students reported that these methods were useful for better level of knowledge. It was found that the use of only one method of printed models received the least score (11.12%) in motivation of learning.

4. DISCUSSION

Human anatomy education and teaching with combination of different methods will continue to develop and transform with advances in different medical sciences and future directions. Several studies conducted on the anatomy education process have produced a wide range of results and conclusions. These studies have evaluated the use of dissections in the anatomy education process and the use of 3D educational models. It is known that dissection has been the main key and anatomy learning tool for more than 400 years and this method is still important part in learning anatomy and becoming medical professionals in different fields (Mwachaka, Saidi & Mandela 2016). Ghosh (2017) underlined that between debates regarding methodologies for teaching anatomy to the students, dissection continues to remain a cornerstone of anatomy curriculum. The role of dissecting of sessional anatomy teachers in medical education was reported by Rhodes, Fogg & Lazarus (2018). The study by Flack & Nicholson (2018) not only showed role of dissection like a useful tool to learn anatomy but authors also highlighted that it noted effects of personal growth and assisted professional development of students. As noted by Doss & Brooks (2016), an opportunity for current as well as future anatomy educators to experience anatomy in the same way that medical students, provided these educators a mechanism for their own education and an opportunity to improve their instruction. Other study by Eppler et al. (2018) explained that all students of the optional dissection course liked activities there and their learning experience integrated this method in modern teaching demands for implementation in modernized curricula. Findings of our study showed that the importance of dissections in anatomy education has never decreased.

It is understandable that prosection-based courses can be replaced with combination in other modalities to teach anatomy. Fruhstorfer et al. (2011) reported the views of first-year graduate medical students on the use of plastinates. Results showed that this material is an adequate resource for the early stages of undergraduate training but for further learning experience very important are wet cadaveric materials. Based on findings by Bouwer, Valter & Webb (2016), several recommendations were formulated to encourage the correct utilization and integration of method of dissection to enhance the anatomical knowledge of students.

At the present day, 3D models can be used for a variety of teaching and learning purposes. Modern Human Anatomy course may include the use of virtual models. Zilverschoon, Vincken & Bleys (2017) argued that produced and expressed 3D material by teachers and students, demonstrated a special potential for its successful implementation in study process. These models are powerful tools for educational anatomy. Fredieu et al. (2015) explained that digital 3D anatomical models can be created in different ways and possibilities. We agree that these models are very useful to explain functions and/or anatomical relationships between small or complicated structures. In addition, the costs for creation of these models can be relatively low. This ability allows the creation and construction of complicated or several complex models in a relatively short period of time. For these reasons, there can be used different materials, their colors and components. However, the shapes and presentations of these models can impact efficiency in teaching and learning. The study by Murgitroyd et al. (2015) demonstrated and explained the wider uses 3D digital anatomy models for postgraduate teaching, patient education and surgical planning. Some authors mentioned that 3D developed educational materials and innovative teaching modules helped for anatomy education of first-year medical students to demonstrate the variations among patients (Pujol et al. 2016). As noted by Inzunza et al. (2015), there have been developed new methods for 3D printing of models of body segments. For these reasons, there were used computed tomography images or scanner surface. It allowed the authors to generate an accurate reproduction with correct proportions, topographic relations, morphological and color accuracy. It is clear that the additional spatial information and different perspectives give the visualization of a 3D model in dynamic. Berney et al. (2015) explored the interplay between anatomical tasks, learning material, presentation formats and spatial abilities. Findings showed spatial relation abilities and revealed the predictive influence of spatial visualization on performance.

The study by Paech et al. (2017) confirmed that the performance of medical students is significantly improved by the incorporation of life-size virtual dissection table and cadaver CT scans. Providing students with the opportunity to have early contact with medical images prepares them for the clinical

work. We agree with the statement that using different images of virtual dissection table will allow for all students to learn and develop an accurate 3D understanding of several anatomical structures, regions and cross-sections.

Khot et al. (2013) concluded that computer-based learning resources have significant disadvantages compared to traditional materials in learning anatomy. On one hand, this means that the most advantageous is teaching with including both 2D and 3D models. On the other hand, all 3D visualizations should allow students and teachers to interact with models by moving or rotating them to reveal new perspectives of anatomical structures. Wainman et al. (2018) indicated that a physical model is superior to a computer projection. The analysis of results of these authors showed implications for the use of digital technology in spatial learning.

Brown, Stonelake & Anderson (2015) reported that in the acquisition of 3D anatomy knowledge an important role can play virtual dissection Anatomage Table. Findings of this study showed that Anatomage Table explored to the students life-size anatomy and significantly improved the understanding of 3D structures. Similar observations have been made in study by Bharati & Rani (2018). Majority of students strongly preferred the cross-sectional planes and images of Anatomage Table compared the images of text book in learning anatomy. Students agreed that the active ability to rotate and dissect was better in body systems visualizing. Our results coincided with findings of mentioned authors and showed that Anatomage Table can be only added tool to cadaveric dissections in learning anatomy. Other study by Afsharpour et al. (2018) found that students utilizing virtual dissection tables scored higher results on laboratory examinations than the students having cadavers or models.

The decision as to which tool is most useful for anatomy learning is highly debated (Wilson et al. 2018). Findings showed that scores of student performance were found to be statistically equivalent when comparing traditional dissection to other used methods. The authors recommended special research in pedagogical approaches on the long-term retention of anatomical knowledge. We believe that students' knowledge, skills and competencies will be increased by combination of dissection and different innovative ways in future. Additionally, it seems quite important that new and classical methods are integrated in learning and teaching of Human Anatomy course.

5. CONCLUSIONS

In Human Anatomy new, innovative and demonstrative 3D elements together with classical learning methods can motivate students to study this course or other morphological disciplines, increase their interest and the effectiveness in study process. These methods are helpful in formation of practical skills of students for real life situations and development an understanding of the personal position, communication and professional competencies.

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