

Measurement of the basic anatomy knowledge and the satisfaction of students taking an anatomy course with video-animation support

Halil Yılmaz¹ 

¹ Department of Anatomy, Faculty of Medicine, Ordu University. Ordu / Türkiye

Abstract

This experimental study was conducted to determine the self-efficacy perception and distance learning satisfaction of Kozaklı Vocational School students receiving animation-supported anatomy education. The study was conducted on 225 students who took active lessons in the distance education process using the student information form, Distance Education Assessment and Anatomy Self-Efficacy Questionnaires via Google form. It was determined that 51.7% of the participants lived in the city center, 31.8% in the district center, and 16.6% in the countryside. In this study, the total distance education satisfaction score was calculated as 63.20 ± 15.97 and the anatomy basic competence score as 44.84 ± 6.69 . A low positive correlation was found between the proficiency level in anatomy course and satisfaction with distance education ($r = 0.301$, $p < 0.001$). The distance education system has taken its place in academic education permanently and is used extensively. The ability to rewatch lectures, the elimination of accommodation and transportation costs, and the clarity of instructional materials were identified as the most significant advantages of distance education. While inadequate application lessons, lack of internet infrastructure and lack of technological equipment in crowded families were criticized aspects of the system.

Keywords: Anatomy, animation, distance education, questionnaire

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Corresponding Author:
Halil Yılmaz
Email: halilyilmaz855@gmail.com



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Introduction

On 12 January 2020, this new virus was provisionally identified by the World Health Organization (WHO) as the 2019 novel coronavirus 2019-nCoV [1-3]. Governments around the world have imposed similar quarantines and social restrictions to control the pandemic [4]. The most significant impact on academic life has been the transition of universities to distance or online education. There are advantages and disadvantages to this system of education. Online learning allows information to be presented to students in a broader context for theoretical courses. Online learning also allows students from different geographical locations to share the same virtual classroom. However, online education is not sufficient for practical training [5]. The decision by universities to move to distance learning and the reduction in the number of laboratory transport vans has made it difficult to provide practical courses. The teaching of anatomy, which underpins medical education, is also affected because it's based on learning by doing [6,7].

Traditionally, anatomy has been taught using models and cadavers to demonstrate theoretical knowledge. The use of cadavers in teaching is very common and important. However, some institutions do not use cadavers for ethical reasons. Lancaster University Medical School, Peninsula School of Medicine and Dentistry and the University of Limerick Medical School are the only institutions in the UK that do not use human cadavers for teaching anatomy for ethical reasons [6-10].

Anatomy teachers are turning to technology to overcome these practical problems. Mobile applications, virtual reality (VR) and augmented reality (AR) are some of the innovative methods being used. The literature reports that the video conferencing application Google Hangouts (Google Meet) (Google Inc., Mountain View, CA) has been successfully used to teach anatomy to medical students assigned to surgical specialties [11]. The sharing of YouTube videos by students and academics has increased in recent years. These videos have become increasingly popular with students. In fact, according to a survey of

Jordanian medical students, 83.9% of students considered YouTube as a source of information [12]. The impact of technology on the teaching of anatomy is no secret. Computer technology can be used to draw limbs and share them with students [13].

Animative Anatomy uses modern technological advances to enhance educational experience and is an innovative approach to teaching and learning anatomical sciences. This paradigm shift is characterised by the integration of interactive tools such as AR, VR and multimedia resources into the traditional anatomy classroom. These technologies not only facilitate a deeper understanding of complex anatomy but also cater to the diverse learning preferences of students in modern classrooms. Recent research has highlighted the effectiveness of AR in veterinary anatomy education, showing that interactive 3D models significantly improve students' understanding of anatomical relationships [14]. Similarly, the use of multimedia, such as animation and video clips, can stimulate engagement and improve retention of anatomical knowledge, particularly in areas where spatial visualisation is required. VR technologies can further enrich the learning environment, allowing students to explore anatomy in 3D space and improve their spatial awareness and understanding of anatomy [15]. In addition, the COVID-19 pandemic has accelerated the adoption of digital tools in the teaching of anatomy, encouraging educators to explore blended learning approaches that combine traditional dissection with virtual resources [16, 17]. This shift highlights the potential for continued innovation in anatomy education and overcoming the challenges of physical distance. Supporting the effectiveness of these technologies, meta-analyses have shown that VR and AR can significantly improve learners' knowledge and attitudes towards learning anatomy [18,19]. Thus, animated anatomy represents an important evolution in pedagogical strategies for teaching anatomy, promoting a more interactive and engaging learning environment, which is essential for the development of future healthcare professionals. In conclusion, animated anatomy embodies

a transformational approach to anatomy education, integrating advanced technologies to create a more dynamic and effective learning experience. The incorporation of these innovative tools is likely to play a pivotal role in shaping the future of anatomy teaching and learning as educational institutions continue to adapt to the evolving landscape of medical education.

The aim of this study was to investigate the level of basic competence in anatomy and the level of satisfaction of vocational school students using animated anatomy teaching in relation to their distance learning anatomy courses.

Materials and Methods

Ethical approval

Ethical approval for this study was obtained from the Ethics Committee for the Publication of Non-Interventional Clinical Research of Nevşehir Hacı Bektaş Veli University with decision number 2021.07.240. Written and verbal informed consent was obtained from all enrolled subjects before the start of the study.

Study design

This study was powered using GPower 3.1 to determine the sample size required. A minimum of 210 students was required for the study according to the results of the power analysis ($\alpha=0.05$, power $(1-\beta)=0.95$, effect size=0.5). As this sample represented half of our study population, a total of 225 students enrolled in active anatomy courses gave written consent and the study was initiated.

The study was designed for 2 semesters. The training was carried out over a period of 14 weeks, with 4 hours of training per week in each semester. The first semester covered the anatomy of the musculoskeletal system and the second semester covered the anatomy of the respiratory, circulatory, digestive, genitourinary and nervous systems.

As part of the study, the training was uploaded to a personal YouTube video page (Figure 1). To overcome this lack of practical training, in addition to the video recordings, animated videos of 3D Lyon Anatomy (with email approval) were used for the application courses

(Figure 2) [20]. The videos were viewed by the teacher in the virtual classroom. The virtual classroom system recorded student progress. The evaluation of this study was carried out using the Student Information Form, the Distance Learning Evaluation Questionnaire [21], the Anatomy Basic Competence Questionnaire and Google form using open-ended questions. The Anatomy Basic Skills Questionnaire consists of 18 questions, each worth 1-5 points, with a minimum of 18 and a maximum of 90 points.

The Distance Learning Evaluation Questionnaire consists of 18 questions, each worth (1-5) points, with a minimum of 18 and a maximum of 90 points. According to the total score of the questionnaires, an increase in the score indicates an increase in the level of anatomy competence and interest in distance learning and vice versa.

Open ended-questions

- 1- In your opinion, what are the 3 positive aspects of distance learning?
- 2- In your opinion, what are the 3 negative aspects of distance learning?

Statistical analysis

Sociodemographic characteristics were used descriptively and expressed as percentages (%). Pairwise comparisons were made with participants grouped by gender, program and class. Normal distribution analysis using 5 parameters (*skewness-kurtosis*, standard deviation/mean, Q-Q plots, histogram, *Kolmogorov-Smirnov* test) was performed for independent variables in the statistical analysis of the study. Normally distributed data were presented as the standard mean \pm standard deviation (MEAN \pm STD), and the *independent samples t-test* was used for pairwise comparisons, with $\alpha = 0.05$ and $p < \alpha$ considered significant. The relationship between basic anatomy competence and interest in distance learning was tested using *Pearson correlation* analysis. The IBM® SPSS® 23.0 software was used for statistical analysis.

Results

Sociodemographic findings

It was found that 51.7% of the participants lived in the city center, 31.8% in the district center and 16.6% in rural areas. Of the students who participated in the survey, 52.9% were enrolled in physiotherapy and 47.1% were enrolled in occupational therapy. While 53.3% of the participants were enrolled in the first year, 46.7% were enrolled in the second year.

Findings by gender

The study involved 180 female and 45 male participants. Firstly, basic competence in the anatomy course and interest in distance learning were compared according to gender. Male students scored 43.34 ± 4.71 , while female students scored 45.21 ± 5.20 on the Anatomy Course Basic Competence Questionnaire. The difference was not statistically significant ($p > 0.05$) (Table 1). Male students scored 48% of the maximum score and female students scored 50% of the maximum score.

Male students scored 64.40 ± 8.13 and female students scored 62.91 ± 9.21 for interest in distance learning and there was no statistically significant

difference between them ($p > 0.05$) (Table 1). In the questionnaire on interest in distance learning, male students scored 72% of the maximum score and female students scored 70%.

Findings by departments

There are two associate degree programs in the vocational school where anatomy courses are given: physiotherapy and occupational therapy. 118 physiotherapy students and 107 occupational therapy students participated in the study. The physiotherapy students scored 45.22 ± 6.31 points on the anatomy basic skills questionnaire, while the occupational therapy students scored 44.43 ± 6.21 points, and there was no difference between the students in the anatomy basic skills scores ($p > 0.05$) (Table 1). According to the Anatomy Basic Skills Questionnaire, students in both departments achieved approximately 50% of the maximum score.

In the interest in distance learning questionnaire, physiotherapy students scored 60.66 ± 9.71 points, while occupational therapy students scored 66.03 ± 10.51 points, and the difference between the two groups was found to be statistically significant ($p < 0.05$) (Table 1). According to this questionnaire, physiotherapy students received

Table 1. Comparison of anatomy basic competence and interest in distance education according to groups.

	Anatomy basic competence	Interest in Distance Education
Gender		
Male (n=45)	43.34 ± 4.71	64.40 ± 8.13
Female (n=180)	45.21 ± 5.20	62.91 ± 9.21
Sig. (p)	0.096	0.580
Class		
First-year (n=119)	45.22 ± 6.31	60.66 ± 9.71
Second-year (n=106)	44.43 ± 6.21	66.03 ± 10.51
Sig. (p)	0.382	0.012*
Program		
Physiotherapy (n=118)	45.03 ± 5.82	63.77 ± 5.52
Occupational Therapy (n=107)	44.43 ± 4.69	62.57 ± 6.55
Sig. (p)	0.660	0.576

Variables are shown mean \pm standard deviation (MEAN \pm STD)

Independent samples t test was used in comparison of two independent groups.

Related samples t test was used in comparison of two dependent groups.

* There is a difference between groups in the 95% confidence interval ($p < 0.05$)

66% of the maximum score, while occupational therapy students received 73%. Occupational therapy students are more satisfied with the distance learning system than physiotherapy students.

Findings according to grade level

119 first-year students and 106 second-year students participated in the study. According to year level, the anatomy basic competence score

of the first-year students who participated in the study was 45.03 ± 5.82 , while that of the second-year students was 44.43 ± 4.69 , and there was no difference between year levels ($p > 0.05$) (Table 1). In this questionnaire, the item *“I would not want to take this course from someone who has not had anatomy training”* received the highest score among all students (3.43 ± 0.83). In addition, the item *“Having to use knowledge of anatomy in my work causes me distress”* received the

Table 2. Correlation analysis between anatomy basic competence and interest in distance education.

Interest in Distance Education	Anatomy basic competence
Pearson Correlation (r)	0.301*
Sig. (p)	<0.001

Pearson Correlation analysis evaluated.

* There is a low positive correlation between the data ($0.30 < r < 0.50$, $p < 0.001$).

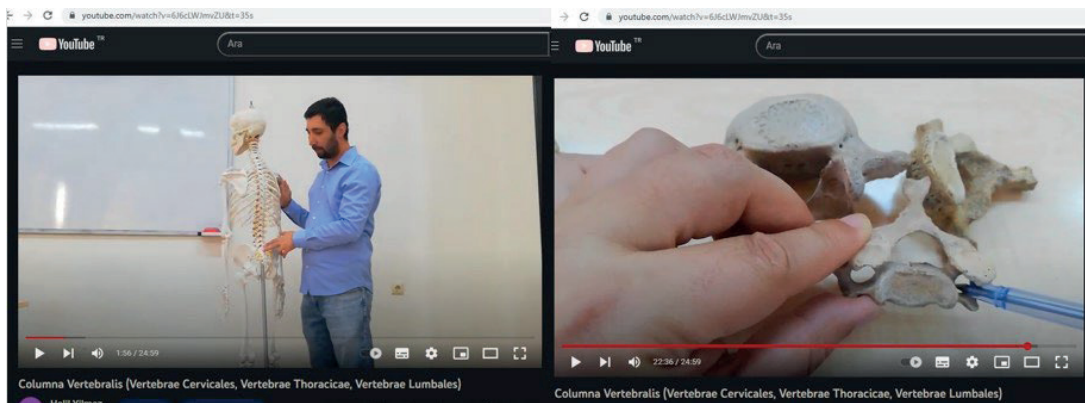


Figure 1. Online anatomy lesson video demonstration.

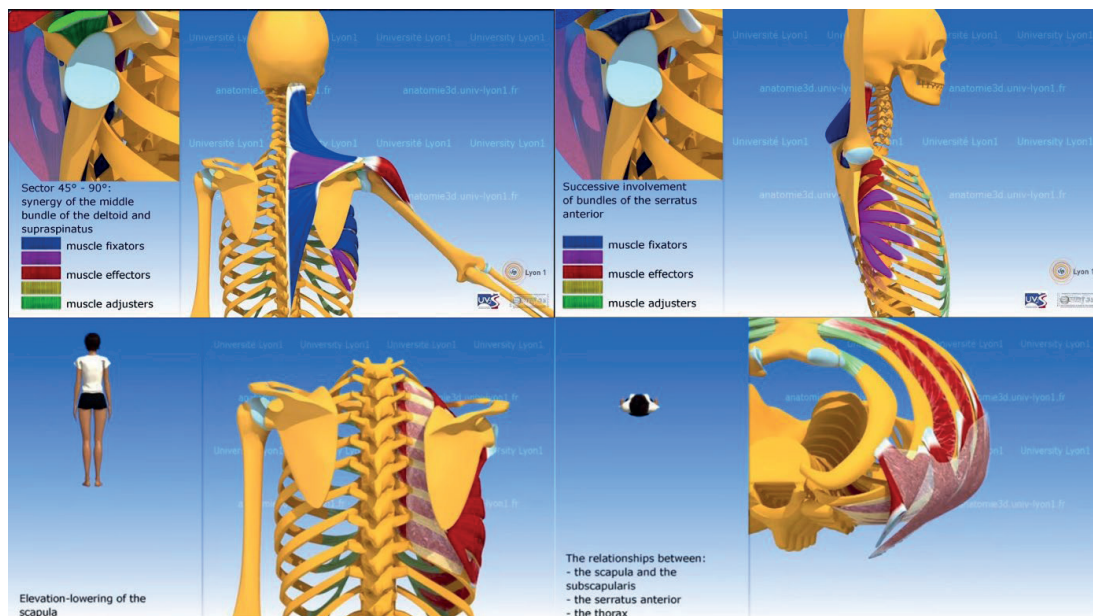


Figure 2. Anatomy education with video animation via 3D Anatomy Lyon [20].

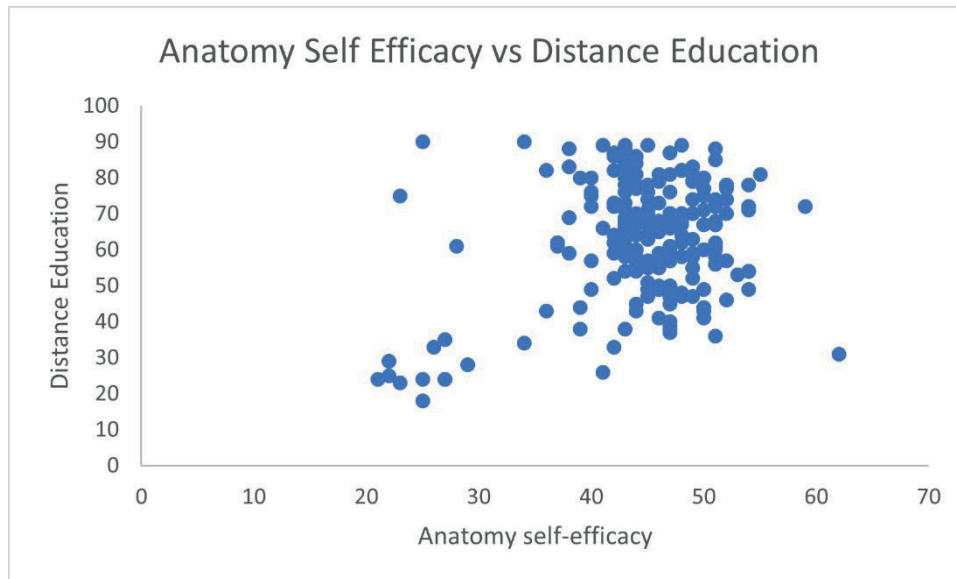


Figure 3. Correlation of anatomy basic competence and interest in distance education.

lowest score among all students who participated in this survey (2.05 ± 0.79).

In the distance learning questionnaire, students in the 1st year received 63.77 ± 5.52 points, while students in the 2nd year received 62.57 ± 6.55 points and there was no statistically significant difference between the groups ($p > 0.05$) (Table 1). In the distance learning survey, the question “*I know that I can access and use the recordings of live lectures that I could not attend later*” received the highest score among all students (4.43 ± 0.93). In the distance learning survey, the question ‘I think that the virtual classroom application is equivalent to face-to-face teaching’ received the lowest score among all students (2.42 ± 0.32).

Correlation analysis

The relationship between basic competence in the anatomy course and interest in distance learning was assessed using the Pearson correlation test. A low positive correlation was found between the level of competence in the anatomy course and satisfaction with distance learning ($0.30 < r < 0.50$, $p < 0.001$) (Table 2). (Figure 3).

Analysis open-ended questions

The last two questions of the Distance Education Evaluation Questionnaire were open-ended, and the participants were asked to list 3 positive and 3 negative characteristics of distance education. The students defined the positive effects of distance learning as the possibility to revisit the courses, the

elimination of accommodation and transport costs, and the quietness and clarity of the classroom. The negative effects of distance learning are insufficient practice courses, insufficient internet computers and technological equipment in overcrowded families. Students who received more than one distance learning course reported that distance learning is a network. 62 students mentioned internet connection problems (poor quality of the internet network, synchronization problems in the courses, video-audio losses) as 1 of the 3 most negative aspects of the distance education system.

In this study, the total satisfaction score of distance education was calculated as 63.20 ± 15.97 and the score of anatomy basic competence as 44.84 ± 6.69 .

Discussion

The discussion of animated anatomy highlights its transformative role in anatomy education, particularly in the context of evolving pedagogical strategies that integrate technology. Animated anatomy involves the use of advanced tools that have been shown to enhance the learning experience of students in various medical and veterinary disciplines, such as AR, VR and interactive multimedia resources. Incorporating these technologies not only addresses the limitations of traditional cadaver-based learning, but also the diverse learning styles of today’s students. One of the key benefits of animated anatomy is its ability to encourage active learner engagement. For example, research has shown that

interactive 3D models significantly improve students' spatial understanding of anatomical structures and their ability to visualise complex relationships within the human body [14,22]. This is particularly relevant in veterinary education, where haptic exposure to specimens is critical to the development of practical skills [22]. In addition, well-designed interfaces can facilitate better learning outcomes by reducing extraneous cognitive demands, as the use of e-learning tools such as Netter's 3D Interactive Anatomy has been shown to affect cognitive load [23]. In addition, the COVID-19 pandemic has spurred the adoption of blended learning models that combine traditional methods with digital resources. These changes have encouraged educators to explore innovative approaches to teaching anatomy, including virtual dissections and online interactive modules [24,25]. Research suggests that while cadaver dissection remains a valuable method of learning anatomy, the integration of digital tools can provide alternative strategies to improve student engagement [26,27]. For example, the Anatomize table, which enables virtual dissection and 3D reconstruction of anatomical structures, has been recognized as an effective teaching tool that complements traditional learning methods [28,29]. Furthermore, the importance of multisensory learning experiences in anatomy education cannot be overemphasized. Methods that combine visual, tactile and kinaesthetic learning modalities have been shown to improve students' understanding of spatial anatomy [30,31]. For example, haptic feedback and movement-based learning have been identified as effective methods for improving classroom understanding of anatomical relationships [32]. Such approaches are consistent with the principles of competency-based medical education (CBME), which emphasise the integration of theory and practice and the promotion of lifelong learning [33]. In conclusion, animated anatomy, driven by technological innovations that enhance student engagement and understanding, represents a significant advance in the field of anatomical education. The integration of these interactive tools is likely to play a pivotal role in shaping the future of anatomy teaching and learning as educational institutions continue to adapt to

the changing landscape of medical education. The continued exploration of blended learning models and the incorporation of multi-sensory experiences will further enrich the educational landscape and ensure that students are well prepared for their future clinical practice.

Distance learning has become an important part of the education system as a result of the development of technology. For both teachers and students, this new educational system brings both opportunities and unknowns. In particular, the anatomy course has developed a natural bias due to its intense visual elements. The results of our study show that these biases are not present when distance learning is supported by video lectures and animations. In terms of anatomy competence, the participating students achieved 50% of the total score. In the distance learning satisfaction survey, they scored around 70% of the total.

A previous study found that while students preferred face-to-face learning and perceived it as more serious, their exam results were higher in distance learning. In this study, students said that although they were initially sceptical about distance learning, they had become more accepting of it over time and found it particularly useful in theoretical courses.

Another previous study, which measured the interest of students in different departments in anatomy education, reported that physiotherapy and rehabilitation students felt more competent than nursing and midwifery students [34]. In this study, there was no difference in basic anatomy competence between occupational therapy and physiotherapy students. We believe this is because the content of the two programs is similar.

Another study in the literature, which examined the contribution of blended anatomy teaching enriched with online learning resources for students with theoretical courses, reported that students were more successful in their studies than in traditional teaching [35]. The control mechanism for students was weak in this decentralised system, where students took the exam on an individual basis at the university where this research was carried out. Therefore,

exam results were not included in the study.

In a previous study, researchers defined three different learning methods in anatomy education study: notes, video and AR. The results of the questionnaire method were used to compare students' time spent, knowledge gain, metacognitive perceptions and study data. The results showed that students trained in AR were the most satisfied and gained the most learning, while those trained in traditional theory were the least satisfied and gained the least learning. It was also found that AR students were quicker to adapt to the technology [36]. In our study, despite initial scepticism, students quickly adopted and enjoyed animated anatomy.

A previous study involving 19 countries and 79 medical schools found that distance learning provides an excellent environment and access to technology for students with limited financial resources [37]. In this study, students reported that they initially struggled to access the internet due to financial constraints and lack of technology in families with many siblings. However, as they were able to save on transport and accommodation costs, they reported that their use of technology increased in subsequent periods.

Conclusion

Distance learning has become an integral and widespread part of academic education. Distance education is expected to become a widely adopted global platform in 21st-century education. To overcome the disadvantages of distance education, the government should support the Internet infrastructure and smart devices, and teachers teaching application courses should be provided with technological software devices such as videos, applications and games to enhance the efficiency and enjoyment of teaching.

Limitations

The main limitation of this study is that we were not able to create a control group in our study, as the law requires that all students receive the same education.

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Conflict of interest

There is no potential conflict of interest.

Data availability statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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