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Explaining Skeletal System Anatomy with Classical Method, Video Assisted Method and 3D Imaging Techniques and Comparison of Learning Levels Between Methods

Explicar la Anatomía del Sistema Esquelético con el Método Clásico, el Método Asistido por Video y las Técnicas de Imágenes en 3D y la Comparación de los Niveles de Aprendizaje entre los Métodos

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SUMMARY: The aim of this research is to introduce the ideal lecture technique to the literature by explaining the anatomy of the skeletal system using the classical method, video-assisted method and 3D imaging techniques. The research was carried out with 180 students. The number of samples was determined by power analysis (a=0.05,b=0.20, effect size=0.25). Participants were pre-screened and divided into 4 groups with the closest group mean (group 1: control group: the group that did not take anatomy lessons, group 2: video-assisted anatomy education, group 3: 3D anatomy course, group 4: classical anatomy education group). The courses in the training groups were organised as 4 hours/day, 2 days/week for 5 weeks. At the end of the course, the students were re-examined and scaled to determine the difference in scores and self-efficacy between the groups. A one-way ANOVA test was performed because the data were normally distributed when comparing between groups. The mean scores were calculated as group 1=30.22±6.24, group 2=39.02±9.15, group 3=49.77±9.20 and group 4=59.28±8.95. In the *post hoc* comparison, in pairwise comparisons between all groups, the differences were highly significant ($p<0.001$). According to the results of the self-efficacy scale, the groups were ranked as group 4>group 3>group 2>group 1 ($p<0.001$). According to the results of this study, the laboratory method in skeletal anatomy teaching is the best alternative to 3D anatomy teaching.

KEY WORDS: Anatomy; Education; Skeletal System Anatomy; Video-assisted; 3D.

INTRODUCTION

The transition of universities to distance or online education is the most significant impact on academic life after the pandemic (Raveendran & Jayadevan, 2020; Sun *et al*., 2020; Wang *et al*., 2020; Hu *et al*., 2021). This new application has advantages and disadvantages. For theoretical courses, online learning allows information to be presented to students from a broader perspective. Online learning also allows students from different geographical locations to share the same virtual classroom. However, the online method is not sufficient for practical training. The decision of universities to switch to distance learning and the limited number of vehicles available to transport laboratories create difficulties for practical courses. The teaching of anatomy, which is the basis of medical education, is also affected by this process because it is based on applied practical training (Chung *et al*., 2021).

Anatomy teaching involves the practical demonstration of traditional theoretical knowledge on models and cadavers. Cadaver teaching is extremely common and important, and in England, Lancaster University School of Medicine, Peninsula School of Medicine and Dentistry and Limerick University School of Medicine are institutions that do not use human cadavers for teaching anatomy on ethical grounds (Heylings, 2002; O'Doherty *et al*., 2018; Brassett *et al*., 2020).

To overcome these problems in practice, anatomy teachers are embracing the benefits of technology, favouring innovative methods such as mobile applications, virtual reality and augmented reality (Pather *et al*., 2020).

It has been reported in the literature that the videoconferencing application Google Hangouts (Google

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Meet) (Google Inc., Mountain View, CA) has been successfully used for anatomical training of medical students assigned to surgical specialties (Moszkowicz *et al*., 2020).

Nevsehir Hacı Bektas Veli University Kozaklı Vocational School received approval by mail and application lessons were made with 3D Lyon Anatomy and Muscle & Motion animation videos and this application deficiency was solved.

The aim of this study is to determine the self-efficacy and satisfaction with distance learning of students who receive video-assisted anatomy education.

MATERIAL AND METHOD

Study design. Students who completed one semester of the anatomy course and were promoted to the upper class were included in the study.

Students who took a break from our five-week course for various reasons were excluded from the study.

The students took a pre-examination. According to the results of this exam, the students were randomly divided into groups so that the mean scores were as close as possible.

Teaching method

Group 1: Control group; no additional anatomy course was organised for this group with the support of the teacher. However, students were encouraged to work individually with the atlas.

Group 2: Video-assisted anatomy course; Students in this group were given a video-assisted anatomy course with the support of the teacher.

Group 3: 3D anatomy training; 3D skeletal anatomy training was given to this group of students in the presence of an instructor. The training took place in the computer lab. First, the instructor taught the group, then the students moved to the computer and received hands-on training under the supervision of the instructor.

Group 4: Classical training group; Students in this group received theoretical training in the classroom environment one day a week and training with models in the laboratory environment on the other day of the week.

Participants. In the study, the sample size was determined by power analysis using the Gpower 3.1.9.4. program. According to the results of the power analysis (a=0.05 b=0.05, effect size=0.25), a total of 180 people, 45 in each group, were studied. Considering the student status of the Therapy and Rehabilitation department, 75 % of the participants were selected as female and 25 % as male.

Ethics committee. This study was published by Nevs¸ehir Hacı Bektas¸ Veli University Non-Invasive Clinical Research Publication Ethics Committee on 2021.09.326. It was approved by resolution no. Written and verbal consent was obtained from all participants before the study (Annex-1).

Outcome measures

Questionnaire evaluation: The Human Anatomy Course Perception of Self-Efficacy Scale35 was used for evaluation. Items believed to affect the self-efficacy of the anatomy course (Bahçeci & Kuru, 2006) were created and presented to three experts, one of whom is a Turkologist and two of whom are field educators, for structure, content and language validity. After the validity study, the wording of some items was changed, some items were removed completely and the draft scale was reduced to 30 items. The Cohen kappa coefficient of the 30-item scale was calculated to be 0.74.

The remaining items were subjected to a factor analysis. At the end of the analysis, items with an item load value of less than 0.40 and undifferentiated items (with a difference between load values of less than 0.10) were removed from the scale, of which six were negative and 20 were positive. A total of 26 items consisting of expressions were formed. The reliability coefficient of the scale was calculated as Cronbach's alpha (a) 0.84.

The scale is Likert type and the lowest score to be taken from the scale is 26 and the highest score is 130. Self-efficacy levels are calculated as follows;

26-43 points: Very low
44-60 points: Low
61-96 points: Medium
97-113 points: High
114-130 points: very high.

Exam evaluation: Questions on skeletal anatomy were prepared for the students for educational evaluation. The examination was marked out of 100 full marks out of 25 questions, each question being worth 4 marks.

Statistical analysis. Sociodemographic characteristics were used as descriptors and expressed as percentages (%). Participants in the study were grouped by gender, programme and class, and paired comparisons were made. In the statistical analysis of the study, normal distribution analysis was performed using 5 parameters (skewness-curvature, standard deviation/mean, Q-Q plots, histogram, Shapiro-

Wilk test) on the independent variables. Normally distributed data were presented as mean ± standard deviation (MEAN±STD). One-way ANOVA test was performed because the data were normally distributed in the comparison between groups, *post hoc* test was used when group variances were not homogeneous (Levene test <0.05) Tamhane test and *post hoc* Tukey test was used when group variances were homogeneous (Levene test>0.05). Parametric data were presented as mean±standard deviation (MEAN±STD), a=0.05 was selected and p<a was considered significant. IBM SPSS 23.0 was used for statistical analysis.

RESULTS

Scale results. This scale consists of three sub-dimensions and a total score index by combining these three sub-dimensions.

a1 sub-dimension. This sub-dimension measures students' confidence in their knowledge of anatomy. This sub-dimension has 11 questions and is scored between (11-55). The groups were listed as Group 4> Group 3> Group 2> Group 1 and a statistically significant difference was found between the groups (p<0.001) (Table I).

a2 sub-dimension. This sub-dimension measures the level of awareness of practical skills in anatomy and consists of 7 questions and is scored between (7-35). The groups are listed as Group 4 > Group 3 > Group 2 > Group 1. While the difference between Group 2 and Group 1 was statistically significant (p<0.005), the difference between all other groups was statistically very significant (p<0.001) (Table I).

a3 sub-dimension. In this sub-dimension, the ability to transform the theoretical knowledge of anatomy into a life skill was assessed and scores were given from 8 questions (8-40). The statistical difference between the groups was significant and the groups were listed as Group 4> Group 3> Group 2> Group 1. The difference between Group 1 and all other groups is highly significant (p<0.001), the difference between Group 2 and Group 3 is highly significant (p<0.01), the difference between Group 4 is highly significant (p<0.001), Group 3 and Group 4 the difference between the two was found to be statistically significant (p<0.05) (Table I).

Total scale. It consists of all the questions of the Human Anatomy Course Self-Efficacy Perception Scale questionnaire and the sum of three subscales. This scale consists of a total of 26 questions and a minimum of 26 and a maximum of 130 points can be obtained. The groups were listed as Group 4> Group 3> Group 2> Group 1 and the difference between all groups was found to be very significant (p<0.001).between all groups was found to be very significant (p<0.001) (Table I).

Results of exam. Evaluates the results of the post-study exam. The exam consists of 25 questions and is scored between 0-100. The groups were ranked as Group4 > Group 3< Group2> Group 1 according to the test scores, and the differences between all groups were found to be statistically very significant (p<0.001) (Table I).

Table I. Scale and exam scores of the participants who received training with different methods (*p<0.05, **p<0.01, ***p<0.001).

	Group 1	Group 2	Group 3	Group 4	Sig. (p)
Sub Dimension 1 (X)	26.53±3.96	33.35±4.31^{a***}	37.28±5.83^{a***b***}	41.28±4.91^{a***b***c**}	<0.001
Sub Dimension 2 (Y)	16.62±2.01	19.97±3.07^{a***}	22.43±4.43^{a***b*}	25.42±3.99^{a***b***c**}	<0.001
Sub Dimension 3 (X)	17.57±3.16	22.48±3.47^{a***}	25.50±4.75^{a***b**}	28.19±4.38^{a***b***c*}	<0.001
Total Scale Score (Y)	60.73±7.04	75.82±9.63^{a***}	85.21±12.97^{a***b***}	94.90±12.19^{a***b***c**}	<0.001
Exam Score (Y)	30.22±6.24	39.02±9.15^{a***}	49.77±9.20^{a***,b***}	59.28±8.95^{a***,b***,c***}	<0.001

(Group 1: control group, Group 2: Video-assisted group, Group 3: 3D education group Group 4: Laboratuary group).
Parametric data are shown as Mean±standard deviation (MEAN±STD). Multi-group comparisons were made with the One Way Anova Test, if the variances were homogeneous (Levene test p value >0.05) in post hoc comparisons, Tukey, if the variances were not homogeneous (Levene test p value<0.005) Tamhane test was applied (X: Tukey Test, Y: Tamhane Test)
a; The difference between groups is statistically significant when compared with group 1.
b; The difference between groups is statistically significant when compared to group 2.
c; The difference between groups is statistically significant when compared with group 3.

DISCUSSION

In our study, we attempted to determine the most ideal educational method for teaching skeletal anatomy by comparing three different teaching techniques. We believe that alternative methods should be included in the literature, given the limitations of laboratory use and the development of technology during pandemic periods. In our study we

measured student success in terms of examination results and student interest and approach using the scale method. It was found that the best method of teaching skeletal anatomy is face-to-face teaching in the laboratory and the best alternative is 3-dimensional teaching. We observed that both the interest in the course and the success rate were low, as video-assisted anatomy teaching reminded the students of the pandemic period of education.

In a previous study that found that students preferred face-to-face to distance education, they did not take distance education as seriously as face-to-face education, but exam results were higher in distance education (Metin *et al*., 2017). According to the results of our study, we can see that the proficiency of video- and 3D-assisted anatomy teaching has increased, thus increasing the success rate. The high scores in the exam may be due to the remote nature of the exam administration method and the corresponding low control mechanism. The students in our study, on the other hand, stated that although they did not initially adopt the distance learning alternative of video-assisted education, this form of education would be beneficial in the future for theoretical teaching. The fact that they could access the course materials whenever and as often as they wanted may have led to this result.

The study found that in the study where anatomy education measured the interest of students in different departments, physiotherapy and rehabilitation students felt more competent than nursing and midwifery students (Acar, 2018). In the study by Acar *et al*. (2018) physiotherapy and rehabilitation students' sense of competence in anatomy education may be due to more intensive anatomy education depending on the curriculum. In our study, there was no difference in anatomy self-efficacy between occupational therapy and physiotherapy students. We believe that the reason for this is that the two programmes basically include similar disciplines.

In the study defined three different learning methods as note, video and augmented reality in their study on anatomy education. The time spent by the students, the learning they gained, metacognitive perception and study datas were compared according to the scores obtained from the questionnaire method (Ferrer-Torregrosa *et al*., 2016). According to the results of this study, among the participants, the highest score among the participants were those students who received augmented reality education and the least students who received classical theoretical education. In the study, it was stated that the students adopted the augmented reality faster. In our study, although the students were biased at first, they quickly adopted visual video broadcasts and found them more fun. Similarly, in our study, students quickly adopted visual video broadcasts covering augmented reality and found it more entertaining.

In the study which produced a post-Covid planning map for medical students involving 19 countries and 79 faculties, they found that distance learning provided a good environment for students and that students with financial difficulties had access to technology (Ahmed *et al*., 2020). In this study, students reported that it was initially difficult to access the Internet for financial reasons and that there was a lack of technological equipment in families with many siblings. However, in subsequent periods, they reported that the use of technological devices increased with the savings made on transport and accommodation costs. This study therefore supports the findings of the 2020 study.

It is an important limitation that cadaveric training, due to school facilities, cannot be included in the study. Another limitation of our study is that it is single-centred and the participants are only associate degree students. In order to change the literature, we believe that it would be beneficial to carry out similar studies in different universities and with students at different levels of education, and to include new teaching techniques in the literature on the teaching of skeletal anatomy.

CONCLUSION

Although the laboratory method is the best way to teach skeletal anatomy, we believe that it is in keeping with the spirit of the times to add this method to traditional teaching, as the best alternative to laboratory teaching is 3D models.

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RESUMEN: El objetivo de esta investigación es introducir la técnica de lectura ideal en la literatura, explicando la anatomía del sistema esquelético, utilizando el método clásico, el método asistido por video y las técnicas de imágenes en 3D. La investigación se llevó a cabo con 180 estudiantes. El número de muestras se determinó mediante análisis de potencia (a=0,05, b=0,20, tamaño del efecto=0,25). Los participantes fueron preseleccionados y divididos en 4 grupos con la media de grupo más cercana (grupo 1: grupo de control: el grupo que no tomó lecciones de anatomía, grupo 2: educación de anatomía asistida por video, grupo 3: curso de anatomía 3D, grupo 4: grupo de educación en anatomía clásica). Los cursos en los grupos de formación se organizaron con 4

horas/día, 2 días/semana durante 5 semanas. Al final del curso, los estudiantes fueron reexaminados y escalados para determinar la diferencia en puntajes y autoeficacia entre los grupos. Se realizó una prueba de ANOVA de una vía debido a que los datos se distribuyeron normalmente al comparar entre grupos. Las puntuaciones medias se calcularon como grupo 1=30,22±6,24, grupo 2=39,02±9,15, grupo 3=49,77±9,20 y grupo 4=59,28±8,95. En la comparación *post hoc*, en comparaciones por pares entre todos los grupos, las diferencias fueron altamente significativas (p<0,001). De acuerdo con los resultados de la escala de autoeficacia, los grupos se clasificaron como grupo 4>grupo 3>grupo 2>grupo 1 (p<0,001). Según los resultados de este estudio, el método de laboratorio en la enseñanza de la anatomía esquelética es la mejor alternativa a la enseñanza de la anatomía en 3D.

PALABRAS CLAVE: Anatomía; Educación; Anatomía del Sistema Esquelético; Asistido por video; 3D.

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