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The Effect of Crossword Labs on Knowledge and Attitudes of Nursing Students in Learning Anatomical Terms: A Quasi-experimental Study

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Abstract

Background: The use of active learning methods in teaching anatomical terms is becoming increasingly widespread. Students often struggle with learning anatomical terms, but digital learning tools can make learning easier.

Aim: This study was carried out to determine the effect of Crossword Labs (CL) on the knowledge and attitudes of nursing students in learning anatomical terms.

Methods: A quasi-experimental pre-post test study was conducted with 99 first-year nursing students. The students were divided into traditional (n=47) and CL (n=52) groups according to whether the last digit of their student number was even or odd. Data were collected between December 2021 and January 2022. Students completed the *Descriptive Characteristics Form*, *Anatomical Terms Knowledge Test*, and *Anatomy Lesson Attitude Scale*. The CL exercises were prepared by the researchers using the "CL" program for terminology learning. Students in the CL group solved the exercises and shared their solutions on the "Padlet" platform with their peers and researchers. Wilcoxon and Mann-Whitney U tests were used to analyze the data.

Results: The CL group had a pre-knowledge score of 11 (10-13) and a post-knowledge score of 13 (12-15). A statistically significant difference was found between the post-knowledge scores of the CL and traditional groups (p=0.008). However, no statistically significant difference was found between the post-attitude scores of the two groups (p=0.961).

Conclusion: Students can be tutored outside the classroom at any time and place when learning anatomical concepts. It is recommended that active learning methods be incorporated into the curriculum to help ensure the retention of difficult-to-learn information.

Keywords: Anatomy, learning, nursing students

Introduction

Anatomy is a descriptive science that studies the structure of the body.[1,2] It requires the use of names to describe these structures. Many terms provide information about the shape, size, location, function, or relationship of a structure with other parts of the body.[1] The names in anatomical content constitute its terminology. Terminology comprises all the terms used specifically in an art, a science, or a technique.[3] It facilitates communication by providing a common language among healthcare professionals in clinical practice.[4] Anatomical terms used in both theoretical and practical fields ensure alignment with experts in international health. For nursing students, terminology plays an important role in enabling communication with colleagues and teammates, ensuring reliable and effective interaction, and defining nursing practices and interventions.[3] The terminology knowledge gained in anatomy courses can be applied to all areas of nursing practice. In this respect, using terminology correctly and appropriately requires frequent exposure in anatomy classes and reinforcement through repetition. Studies have shown that students often find anatomical terms difficult to learn, remember, and understand because they are derived from Latin and Greek.[5–7] As a result, students frequently resort to passive learning methods, such as memorization.[8] However, this approach can lead to difficulties in learning, boredom, and anxiety, ultimately preventing efficient learning.[9] To increase efficiency in anatomy education, research indicates that interactive and technological methods, such as computer-based animations and extracurricular online activities, when combined with traditional classroom approaches, enhance both academic success and knowledge retention.[10–13] For this reason, active teaching methods are recommended to improve the quality of education, increase student motivation, and facilitate learning. In the literature, Crossword Labs (CL) have been identified as one such active learning method.[14,15]

Crossword Labs are the most popular and common word games in the world, invented by Arthur Wynne in 1913.[8] They are defined as a way to keep the mind active and as a comfortable, fun method for individual or group teaching that can be used by students and nurses.[8,16] In addition, CL can serve as a valuable educational tool that promotes active learning, develops critical thinking, and increases vocabulary. Today, CL has begun to be used as an active learning method, especially in the education of medical, pharmacy, and nursing students.[8,17–20] CL allow learners to grasp new concepts through varied designs while having fun. In addition, they help achieve results learning outcomes while increasing students' motivation, interest, and self-confidence.[21] Studies in the literature have reported that CL are effective in improving nursing students' knowledge

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of epilepsy pharmacology, supporting correct spelling of antiepileptic drugs, and facilitating the understanding of terminology specific to forensic medicine, veterinary medicine, cardiac physiology, women's health, obstetrics, and neonatal nursing practices.[8,16–18] CL also provide students with the opportunity to learn anytime and anywhere by offering a fun and motivating online environment with extracurricular activities.[21] They positively influence students' attitudes toward courses, enhance critical thinking skills, support concept recall, and ensure the retention of learned information.[17,18,20–25] However, no study has yet examined the effect of CL on students' attitudes toward anatomy lessons.

In nursing education, students encounter terminology in anatomy courses during the first semester of their first year, often involving terms from languages other than their own. As a result, students face difficulties in learning these terms. In this study, to help students understand, comprehend, and use these terms when necessary, the CL method, which is one of the active learning approaches, different from classical methods, was used to enable students to learn anatomical terminology while having fun.

Aim

This study was conducted to determine the effect of CL on the knowledge and attitudes of nursing students, in addition to the traditional lesson, in teaching anatomical terms.

Study Hypotheses

H_1: CL significantly improves nursing students' knowledge and attitudes toward anatomical terms compared to traditional methods.

Materials and Methods

Design

This study was conducted as a quasi-experimental study with a pre-test/post-test design.

Sample

The research population consisted of 170 first-year nursing students enrolled in anatomy courses at a University's Department of Nursing. The sample included 99 students (traditional=47, CL=52) who agreed to participate in the research. A power analysis was carried out using G*Power 3.1. According to Zamani et al.[26] in 2021, the minimum sample size per group is 22 (effect size=0.74, power=95%, significance level=0.05). Thus, the sample consisted of 94 participants (Fig. 1).

The inclusion criteria were:

1. Taking the Anatomy course for the first time,
2. Having a smartphone or computer,
3. Having Internet access.

The exclusion criteria were:

1. Previous education in a health-related department,
2. Having taken the Anatomy course before,
3. Not completing the post-test.

Instruments

Data were collected using the Descriptive Characteristics Form, the Anatomical Terms Knowledge Test, and the Anatomy Lesson Attitude Scale.

The Descriptive Characteristics Form was prepared by the researchers based on the literature.[13,26,27] The form consists of five questions in total, including age, gender, difficulty of the anatomy course, and the importance of the anatomy course in professional life. Students answered the questions about the difficulty and importance of the anatomy course on a scale of 1 (not at all) to 5 (very difficult).

The Anatomical Terms Knowledge Test was prepared by the researcher, reviewed by three experts, and the final version was created. The final version of the test was administered to 82 second- and third-year nursing students. Item discrimination and item difficulty indexes were calculated based on the responses. As a result of the analysis, it was determined that 9 out of 25 questions had low item discrimination and difficulty indexes; therefore, these nine questions were excluded. The reliability of the remaining 16 questions was tested using KR-20 and KR-21, and the results indicated acceptable reliability (KR-20=0.65, KR-21=0.78). According to Thompson[28] in 2009, KR-20 values of 0.7 and above are sufficient for tests containing 20 or 50 items. Theoretically, KR-20 ranges from 0.0 to 1.0, with values closer to 1 indicating perfectly consistent measurement.[29] The Cronbach's Alpha value of the test was found to be 0.66. Following these analyses, a 16-question "knowledge test" was used in the implementation phase of the study. Correct answers were scored as "1 point" and incorrect answers as "0 points." The knowledge score was calculated out of 16 points.

The Anatomy Lesson Attitude Scale is an "attitude scale for anatomy and physiology lessons" developed by Kılıç and Güven in 2018.[27] The scale is a five-point Likert type, with items rated as "strongly agree=5," "agree=4," "undecided=3," "partially agree=2," and "disagree=1." The scale consists of 38 items in total. The highest score that can be obtained from the scale is 190, and the lowest score is 38. As the score obtained from the scale increases, it indicates that attitudes improve. The Cronbach's Alpha value of the test was calculated as 0.87. Each statement in the total of 38 items refers to both anatomy and physiology lessons. In this study, with the necessary permission of the scale owner, the words "physiology lesson" were removed from the sentence roots of the scale items, leaving only the expressions related to the "anatomy lesson." In this study, Cronbach's Alpha value was calculated as 0.72.

The preparation of CL was carried out by the researchers using the CL program, which can be accessed free of charge (Fig. 2). The prepared labs included terms covering basic knowledge and concepts in anatomy. Students were asked to write the answers to the given clues in the CL, filling the columns either upward or downward. If the answer was correct, the written term appeared in green; if incorrect, the term appeared in red. Students were then asked to post their answers on a virtual wall prepared by the researcher on the "Padlet" platform (Fig. 3). In addition, the terms in CL (https://wordart.com/) were displayed as word clouds using Word Art (Fig. 4).

Procedure

Data were collected between December 2021 and January 2022. Students who were taking the anatomy course for the first time and agreed to participate in the study were included. After the terminology topic of the anatomy course was explained by the researcher, students completed the *Descriptive Characteristics Form, Anatomical Terms Knowledge Test*, and *Anatomy Lesson Attitude Scale* via a Google

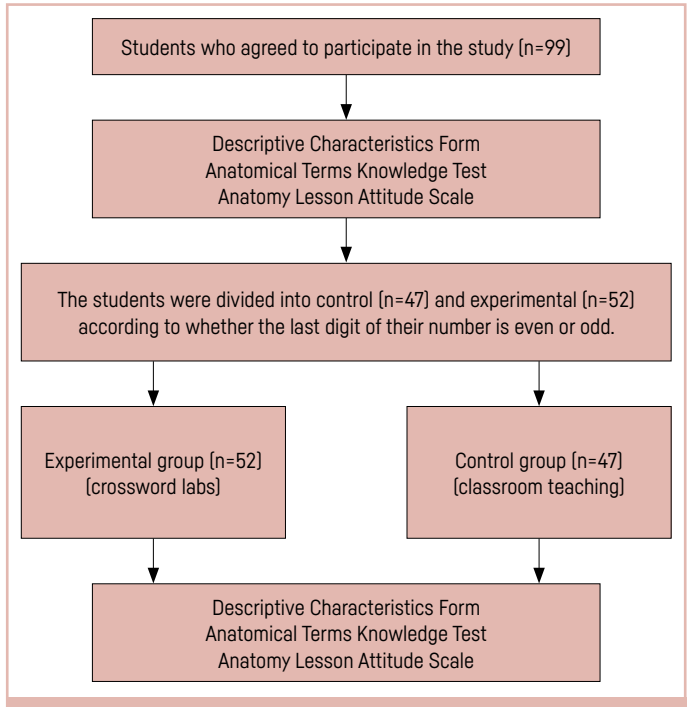

Figure 1. Crossword labs classroom and classroom teaching procedures.

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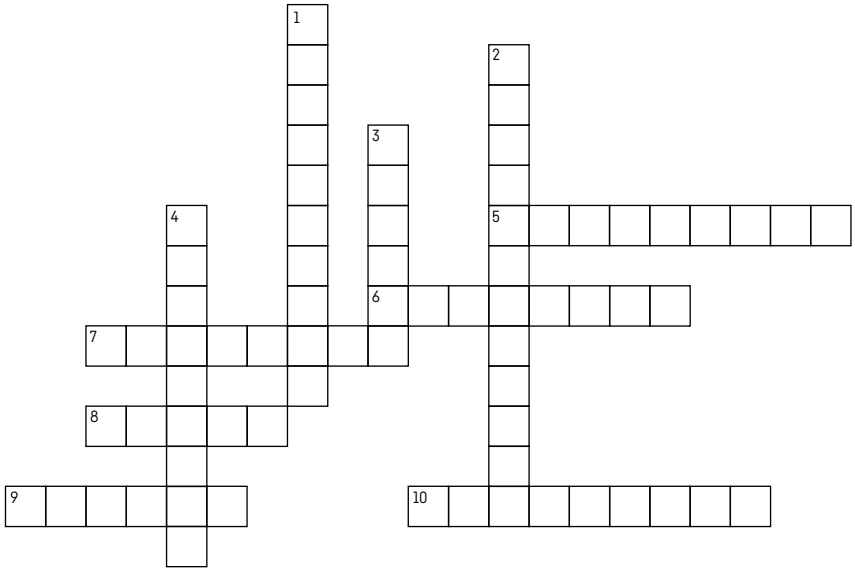

Across

5. Related to or pertaining to the sole of the foot
6. Located on or near the outside; closer to the body surface
7. Below or lower in position; beneath another structure
8. Hand
9. The part of the body between the head and the trunk
10. Located at or relating to the back side of the body

Down

1. Close to the trunk; nearest to the point of origin or attachment
2. Situated away from the center; on or near the surface or outer area
3. Located on or pertaining to the right side of the body
4. Situated farther from the body surface; internal

Figure 2. Crossword puzzles about terms.

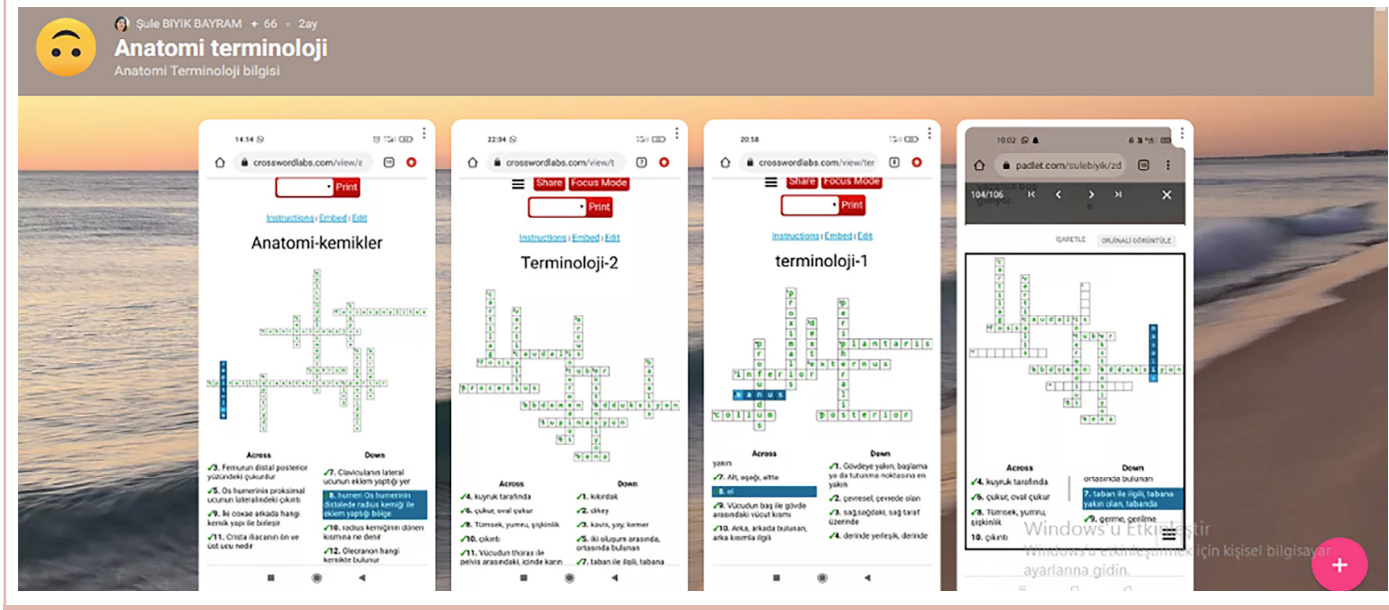

Figure 3. The virtual wall prepared on the "Padlet" platform.

questionnaire (pre-test). Students were divided into the labs group and the traditional group according to whether the last digit of their student number was even or odd. The CL links, prepared by the researchers using the CL program, were sent to the mobile phones of the students in the labs group. These students were asked to solve the CL exercises whenever and wherever they wished and then post their solutions on a virtual wall prepared by the researcher on the "Padlet" platform. Stu-

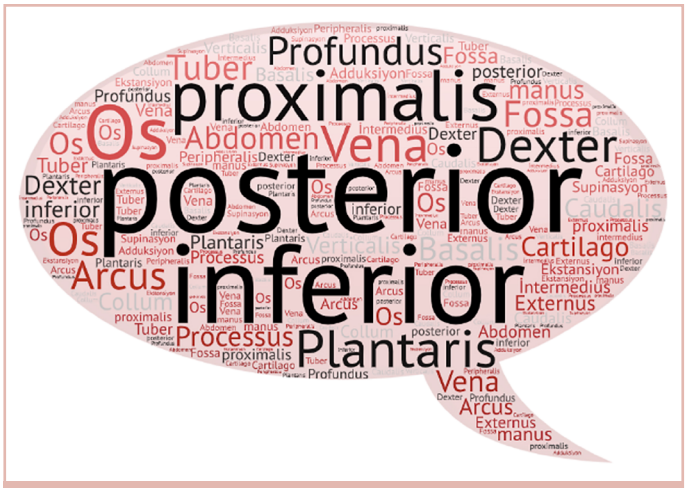

Figure 4. Terms in crossword puzzles.

dents who solved the labs shared their answers on the virtual wall, which was accessible only to the labs group (Fig. 2). Students accessed the virtual wall prepared on the "Padlet" platform using the link sent by the researchers. The researchers checked the students' lab solutions daily by logging into the virtual wall. Messages from the virtual wall were sent to those with missing or incorrect answers. Correct solutions were approved, and students were then allowed to view the answers. In addition, students could ask questions to their peers and the researchers on this wall. By talking to the labs group students, approval was obtained that they would not share information with other classmates. Students were informed that they would first work in the labs group and later in the traditional group. The students in the labs group solved the labs over the course of one week, until the next lesson. On the other hand, the students in the traditional group were not given any additional applications to study after the lesson, and their education continued only with the traditional method. One week later, all students completed the *Anatomical Terms Knowledge Test* and the *Anatomy Lesson Attitude Scale* (post-test) again. After the labs group application was completed and all the data were collected, the CL were also shared with the traditional group students.

Statistical Analysis

The data obtained from the research were evaluated using the SPSS 23.0 (Statistical Package for the Social Sciences, IBM, New York, USA) program. Mean, standard deviation, median, minimum, and maximum values of the measurement data were calculated. The suitability of the data for normal distribution was evaluated with the Kolmogorov-Smirnov test, which showed that the data did not follow a normal distribution. For dependent groups, the Wilcoxon test was used to determine the difference between the pre-test and post-test, and the Mann-Whitney U test was used to determine the difference between the labs and traditional groups. Eta-squared was used to calculate effect size. Data were evaluated at a significance level of $p<0.05$ with a 95% confidence interval.

Ethics Committee Approval

The study was approved by Karadeniz Technical University Faculty of Medicine Scientific Research Ethics Committee (Approval Number: 24237859-943, Date: 15.12.2021). Permission was also obtained from the university. All students were informed about their rights as well as the research purpose, procedure, and confidentiality. Written and verbal informed consent was obtained from all students participating in the study. The study adhered to the principles outlined in the Declaration of Helsinki and complied with established publication ethics guidelines. The authors affirm that no artificial intelligence-supported technology or chatbot was used in the production of this study.

Results

The mean age of the students was 19 years (range: 18–19), with 20.2% male and 79.8% female (Table 1).

Table 1. Descriptive characteristics of students

Descriptive characteristics	Labs group (n=52)		Traditional group (n=47)		Total	
Age: Median (Q_1–Q_3)	19 (18–19)		19 (18–19)		19 (18–19)	
	n	%	n	%	n	%
Gender						
Male	12	23.1	8	17.0	20	20.2
Female	40	76.9	39	83.0	79	79.8

In the labs group, the pre-knowledge score was 11 (range: 10–13), and the post-knowledge score was 13 (range: 12–15). There was a statistically significant difference between pre- and post-knowledge scores of the students in the lab group ($p<0.001$). In the traditional group, the pre-knowledge score was 13 (range: 10–13), and the post-knowledge score was 12 (range: 10–13). There was also a statistically significant difference between pre- and post-knowledge scores of the students in the traditional group ($p=0.042$).

While no statistically significant difference was found between the pre-knowledge scores of the labs and traditional groups ($p=0.061$), the post-knowledge scores were significantly different ($p=0.008$). In the labs group, the pre-attitude score was 111 (range: 106–115.75), and the post-attitude score was 110 (range: 107–115.75), with no statistically significant difference between them ($p=0.805$). In the traditional group, the pre-attitude score was 111 (range: 104–115), and the post-attitude score was 111 (range: 105–115), also with no statistically significant difference ($p=0.559$). It was determined that there was no statistically significant difference between the pre- and post-attitude scores in the labs and traditional groups ($p=0.679$ and $p=0.961$, respectively) (Table 2).

The pre-difficulty scores of the students in the labs group were 2 (range: 2–2.75), and the post-difficulty scores were 2 (range: 2–3). There was a statistically significant difference between the pre- and post-difficulty scores of the students in the labs group ($p=0.022$). The students in the traditional group had pre-difficulty scores of 2 (range: 2–3) and post-difficulty scores of 3 (range: 2–3). There was a statistically significant difference between the pre- and post-difficulty scores of the students in the traditional group ($p=0.010$). However, there was no statistically significant difference between the pre- and post-difficulty scores of the labs and traditional groups ($p=0.137$ and $p=0.060$, respectively). The pre-importance scores of the students in the labs group were 5 (range: 4–5), and the post-importance scores were 5 (range: 4–5). There was no statistically significant difference between the pre- and post-importance scores of the students in the labs group ($p=0.637$). The students in the traditional group had pre-importance scores of 5 (range: 4–5) and post-importance scores of 4 (range: 4–5). There was a statistically significant difference between the pre- and post-importance scores of the students in the labs group ($p=0.001$). There was no statistically significant difference between the pre-importance scores of the labs and traditional groups ($p=0.977$), but there was a statistically significant difference between the post-importance scores ($p=0.031$). The students in the labs group had a benefit score of 4 (range: 4–5), and those in the traditional group had a score of 4 (range: 3–5). There was no statistically significant difference between the labs and traditional group scores ($p=0.655$) (Table 3).

Discussion

This study's findings showed that the CL method used in teaching terminology knowledge in the context of an anatomy course increased the course success of nursing students. Studies in the literature have reported similar results.[8,14–16,18,30–34] The results of these studies indicated that students who studied with CL generally remembered the terms more quickly, found the application useful, increased their knowledge, enabled self-learning, and derived advantages from creative and fun environments.[14–20,28,31,32,35,36] Abuelo et al.[14] in 2016 reported that students found learning new terms boring and difficult, but those who learned with CL remembered the terms better in a shorter time than the rote-learning group, and described CL as useful and entertaining tools. Patrick et al.[15] in 2018 stated that the use of CL improves students' learning, enhances their skills and performance, and

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Table 2. Comparison of students' knowledge and attitude scores

Terminology	Labs group (n=52) median (Q_1–Q_3)	Traditional group (n=47) median (Q_1–Q_3)	U	p*	Eta^2
Knowledge					
Pre	11 (10–13)	13 (10–13)	958.00	0.061	0.027
Post	13 (12–15)	12 (10–13)	846.50	0.008	0.092
p**	<0.001	0.042			
Z	3.995	2.029			
Anatomy course attitude					
Pre	111 (106–115.75)	111 (104–115)	1163.00	0.679	0.004
Post	110 (107–115.75)	111 (105–115)	1215.00	0.961	0.000
p**	0.805	0.559			
Z	0.247	0.585			

*: Mann-Whitney U test, **: Wilcoxon test.

Table 3. Comparison of importance, difficulty, and benefit levels of the anatomy course

Anatomy course	Labs group (n=52) Median (Q_1–Q_3)	Traditional group (n=47) Median (Q_1–Q_3)	U	p*	Eta^2
Difficulty					
Pre	2 (2–2.75)	2 (2–3)	1026.00	0.137	0.022
Post	2 (2–3)	3 (2–3)	968.50	0.060	0.001
p**	0.022	0.010			
Z	2.575	2.575			
Importance					
Pre	5 (4–5)	5 (4–5)	1218.50	0.977	0.032
Post	5 (4–5)	4 (4–5)	940.00	0.031	0.055
p**	0.637	0.001			
Z	0.471	3.186			
Benefit	4 (4–5)	4 (3–5)	0.454	0.655	0.003

*: Mann-Whitney U test, **: Wilcoxon test.

develops their cognitive/mental abilities. It has also been noted that this tool encourages students to learn independently and enables them to learn while having fun. Malini et al.[32] in 2019 reported that, based on student feedback, CL were considered creative and entertaining educational tools that helped them understand new words and concepts in physiology, and that such games were more engaging. The results of these studies suggest that CL, one of today's preferred active learning methods, allows students to learn while having fun, wherever and whenever they want, rather than through memorization. Incorporating CL-like practices into the course curriculum reinforces classroom learning, ensures knowledge retention, makes lessons more enjoyable, makes learning easier, increases students' motivation, and ensures the permanence of the information.

This study also found no statistically significant difference in students' attitudes toward the course between the labs and traditional groups. Similarly, Dolu et al.[23] in 2022 reported that the transfer of anatomy course content and learning methods using technological approaches suitable for distance education increased interest in the course, made it more attractive, and enhanced its importance as students' learning levels improved. As a result of this study, it can be said that although the use of extracurricular active learning methods affects students' attitudes toward the lesson, the CL method alone is insufficient for developing attitudes. It is thought that using more than one method, rather than a single method, may be more effective in improving students' attitudes toward difficult and rote-based lessons, since students have different learning styles. Alternative teaching methods that appeal to diverse learners can be offered, allowing students to study in ways that suit them best. Thus, they can access information in various ways and, at the same time, have the opportunity to review it. Students' interest and attitude toward the course significantly affect learning.

This study found that the difficulty of the anatomy course increased significantly in the post-evaluation of both the labs and traditional groups. Bolatlı[13] in 2021 reported that students stated that there were too many foreign words to be memorized in the anatomy course, and that it was a difficult lesson in this respect. Uzun Bağcı et al.[31] in 2022 stated that students found the anatomy course important for its contribution to their profession, and that their awareness of the subject increased. It is thought that the increase in the difficulty of the students, the fact that they are learning terminology for the first time, their frequent encounters with Latin words during labs activities, and their efforts to solve them will make them realize the difficulty of the subject. The level of difficulty perceived by students regarding the course can also influence their perception of its importance.[13]

This study also found that students in the labs group rated the anatomy lesson as statistically more important than those in the traditional group, but the level of importance did not increase in parallel with the rise in the lesson's difficulty. This may be because students did not work with different alternative methods and their clinical knowledge was still insufficient. Terminology positively impacts team communication and the patient care process.[3] When students begin applying their anatomy knowledge in clinical practice, their perceptions of the importance of the course may change. Greater awareness of the course's importance also reinforces the view that it is advantageous. The student who begins to use theoretical knowledge in clinical practice succeeds in solving problems and adopts the view that the knowledge received is useful.

In this study, both the labs and traditional groups stated that the course was helpful. Similar to these results, in 2020 Serin and Zambak[30] reported in their study with physical education teachers, coaching education students, and nursing students that nurs-

ing students considered the anatomy course necessary and showed more positive attitudes than students in other departments. The results of this study suggest that awareness of the difficulty, importance, and benefit of the course can influence one another, and these factors may affect both success and attitudes toward the course.

Limitation of the Study

The study was conducted with nursing students at a single university. Only terminological expressions determined according to the nursing department anatomy course curriculum were used in the labs. Randomization was not applied in sample selection because there might have been interaction between students. Since this study was conducted at one university and only with first-year nursing students, the findings cannot be generalized to the entire population, which is a limitation of the study.

Conclusion

The use of CL in nursing education was found to significantly enhance students' knowledge acquisition, although it did not affect their attitudes toward the course or their perception of its importance. Interestingly, CL activities increased the perceived difficulty of the course, yet students still reported finding them beneficial. The early introduction of Latin anatomical terms contributes to the perception of anatomy as a challenging subject, reducing students' motivation and academic performance. Nevertheless, these terms remain essential for building a strong professional foundation. Incorporating CL activities more frequently and systematically throughout the semester, alongside traditional teaching methods, can help counteract negative perceptions, sustain student engagement, and foster deeper interest in the subject. Overall, CL supports students' academic development and professional preparation, though future studies with longer interventions and more diverse populations are needed to further evaluate its long-term effects.

Ethics Committee Approval: The study was approved by the Karadeniz Technical University Faculty of Medicine Scientific Research Ethics Committee (Approval Number: 24237859-943, Date: 15.12.2021).

Informed Consent: Written and verbal informed consent was obtained from all students participating in the study.

Conflict of Interest: The authors have no conflicts of interest to declare.

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