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Research Article

Contribution of Coloring Activity to Learning in Anatomy Education

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Abstract

Aim: This study aims to examine the effects of drawing and coloring-based learning methods on students' academic success in anatomy which is one of the basic courses of medical education.

Material and Methods: The study was conducted with 2nd term students of the Faculty of Medicine during the "Circulatory and Respiratory System" committee. Participants were included in the study on a voluntary basis and were divided into two groups according to their learning preferences: those working with traditional methods and those using coloring-based methods. All students were administered a multiple-choice formative exam consisting of 20 questions; then, the scores related to anatomy from the committee's general exam were recorded. The obtained data were analyzed with SPSS 22.0.

Results: 40% of the 70 students participating in the study preferred coloring-based methods. It was determined that the group using coloring showed statistically significantly higher performance in both subject-specific exam scores and general anatomy success scores ($p<0.05$). A significant relationship was found between gender and learning method; it was observed that female students preferred the coloring method more.

Conclusion: Coloring and drawing based learning strategies have enabled students to participate more actively in the learning process and have contributed positively to academic success compared to traditional methods. These methods should be evaluated as low-cost, applicable and multi-sensory interaction alternative learning tools. They provide a valuable contribution in terms of developing strategies that are compatible with individual learning differences, especially in intensive courses in basic medical sciences.

Keywords: anatomy, medical education, active learning, drawing

INTRODUCTION

Anatomy is one of the basic sciences of medical education and is an indispensable discipline for students to understand the structure of the human body and to integrate this knowledge into clinical practice. However, due to the tough terminology and complex structures, anatomy education is often a challenging process for students. Medical students spend a significant amount of time during the semester learning basic anatomical concepts by attending lectures, reviewing textbooks, reviewing two-dimensional visuals, and participating in laboratory sessions (1–5). However, the tough content of the anatomy curriculum raises concerns that this information may not be sufficiently permanent in the long term.

In order to overcome this difficulty, various teaching strategies are being tried in medical education today; there is an increasing tendency towards accessible and cost-effective approaches that will encourage active participation of the student in the learning process. Traditional anatomy teaching is usually faculty-centered,

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with the passive listener role of the student. Cadaver dissections, use of atlases and slide presentations are the basic components of this method. However, there are findings that not every student benefits from these methods in the same extent and that different learning styles should be taken into account (6).

In recent years, student-centered and creative learning techniques have come to the forefront. These include body painting (7–9), clay modeling (10,11), tactile models (12,13) and digital 3D simulations (14–17). Coloring and drawing-based learning methods have attracted particular attention due to their low cost and feasibility, as well as their potential to increase student engagement (18). This method has yielded effective results in courses on surface anatomy and clinical skills in the field of medicine and health sciences (19).

While body painting offers an effective method focusing on the musculoskeletal system, its adaptability to other systems may be limited. At this point, ready-to-paint anatomy atlases developed in recent years come into play; they allow students to learn through coloring without requiring individual drawing skills. However, the number of studies demonstrating the effectiveness of these methods is quite limited. It is important to reveal the effects of these tools, which are thought to attract less attention, especially compared to the three-dimensional visual materials of the digital age, on learning. Rather than being an alternative to conventional anatomy teaching, coloring-based activities are considered as a supplementary and supportive learning tool that enhances students' engagement and understanding. These methods are not intended to replace cadaveric or lecture-based instruction, but to reinforce traditional learning approaches through an active and creative process.

Coloring-based learning encourages students to use their visual, tactile, and motor skills simultaneously. It is suggested that such multisensory learning approaches can increase the retention of information in long-term memory. In addition, students' direct interaction with anatomical structures through coloring can create conceptual integrity and enable them to better understand the relationships between structures.

In this study, the academic success of students using coloring and drawing-based learning methods and students preferring traditional methods will be compared. We aim to put forth the pedagogical value of a cost-effective and accessible method that supports active learning in anatomy education with our results. At the same time, it is thought that such multi-sensory learning applications can contribute not only to short-term academic success but also to long-term clinical competence. In this respect, the study aims to enlighten the way of developing innovative and evidence-based teaching strategies in the field of medicine and health sciences.

MATERIAL AND METHODS

This observational study was conducted with second-year medical students during the 2024–2025 academic year, specifically within the scope of the "Circulatory and Respiratory System" committee. Ethical approval was obtained from the Medical Sciences Ethics Committee of Muğla Sıtkı Koçman University (Decision Date: 06.01.2025, Decision No: 5, Protocol No: 240253). This study was designed within the framework of the constructivist learning theory, which emphasizes the learner's active involvement in the construction of knowledge. In this context, coloring activities were used as a means to support active participation and deeper understanding rather than passive memorization.

At the beginning of the committee, students were introduced to coloring-based resources as an alternative learning method, in addition to traditional learning materials such as textbooks and atlases. Students interested in these materials obtained materials from the relevant painting booklets through their faculty members. The coloring process was carried out by students individually, outside of formal class hours. While this approach encouraged independent learning, the degree of engagement may have varied among participants. These materials suitable for coloring included the external carotid artery and its branches, the subclavian artery and its branches, and anatomical drawings of the fetal circulation system.

In the middle of the committee schedule, a multiple-choice formative exam consisting of 20 questions was administered to assess the students' learning levels. The exam included questions on both topics supported by coloring resources and topics not supported. The distribution was as follows:

6 questions on the subclavian artery and its branches, 5 questions on the external carotid artery and its branches, 5 questions on fetal circulation, and 4 questions on other circulatory system topics.

Students were invited to participate at the end of a scheduled lecture. Participation was entirely voluntary and had no influence on students' course grades. All responses were treated confidentially, and personal identifiers were removed during data analysis. After the exam, the students were informed about the research. Students who wanted to participate in the study signed a voluntary informed consent form and then a questionnaire was administered. In addition to demographic information

such as age and gender, the survey form also requested the student number in order to analyze the relationship between learning method and exam success. In addition, students were asked whether they had taken the relevant board courses before and which learning method they used individually. Learning method options were presented as follows:

1. I study only by reading course sources and atlas.

2. In addition to course sources, I study by coloring.

3. Other: …… (Explain)

A total of 163 students were informed within the scope of the research, 84 of whom agreed to participate in the study voluntarily. However, 14 of these participants were excluded from the analysis because they had taken the relevant course before (repeated the semester). As a result, statistical analyses were performed on the data obtained from 70 participants. After 3 weeks, a committee exam was held for the Circulatory and Respiratory System, and the students' total score from the anatomy course (theoretical + practical exam) was also recorded. The collected data were analyzed to evaluate the relationship between the students' preferred learning method and their exam success in coloring-supported subjects.

Statistical Analysis

IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA) program was used for statistical analysis of the data. The Kolmogorov-Smirnov test was used to evaluate the conformity of continuous variables to normal distribution. For variables that did not show normal distribution, the Mann-Whitney U test was used for group comparisons, and for the analysis of categorical variables, the Chi-square (χ^2) test was used. In all analyses, the significance level was accepted as $p<0.05$.

RESULTS

A total of 70 students participated in the study. 55.7% of the participants were female (n=39), 44.3% were male (n=31). The average age was found to be 19.76 ± 0.86 years. According to their learning method preferences, 60% of the students (n=42) stated that they only worked with traditional materials such as textbooks and atlases, while 40% (n=28) stated that they used coloring-based methods. Participants who chose 1 or 2 along with the "other" option were included in the relevant groups. There was no group that marked only the other option.

A significant relationship was found between gender and learning method preferences ($\chi^2=7.035$, $p=0.008$); it was observed that female students preferred the painting/drawing method more frequently than males.

When the average ages of the students were compared according to their learning method preferences, no statistically significant difference was found (Mann-Whitney U = 548.000, $p=0.606$).

According to the independent sample t-test results, significant score differences were observed between students using the coloring-based learning method and students preferring traditional methods in all topics ($p<0.05$). According to Levene's test results, variances were found to be homogeneous in most comparisons and analyses were performed under the assumption of "equal variances assumed". Multiple-choice exam scores on fetal circulation, subclavian artery and its branches, external carotid artery and other topics were found to be significantly higher in the group using the coloring method. In addition, statistically significant differences were obtained in favor of students using the painting method in terms of general exam score averages. All values are given in Table 1. These results indicate that the painting and drawing-based active learning method can positively affect students' academic success.

Table 1. Comparison of exam scores of students using different learning methods

Subject	Total exam score	Exam score of students prefer coloring (n=28)	Exam score of students not prefer coloring (n=42)	p-value (Mann-Whitney-U)
Fetal circulation	5	4 (0-5) 3.25 ± 1.35	2.5 (0-5) 2.50 ± 1.37	0.022
Subclavian artery	6	4 (2-6) 4.25 ± 1.27	4 (0-6) 3.43 ± 1.42	0.022
External carotid artery	5	3.5 (1-5) 3.50 ± 1.32	2 (0-5) 2.67 ± 1.69	0.038
Other subjects	4	2 (0-4) 2.04 ± 0.92	1 (0-4) 1.40 ± 1.11	0.010
Formative exam score	20	13 (6-19) 13.04 ± 3.58	9 (4-19) 10.00 ± 4.40	0.004
General committee exam score	24	20.95 (11.1-23.2) 19.99 ± 2.96	17.85 (10.10-23.2) 17.59 ± 4.14	0.018

p <0.05
Descriptive statistics are presented as median (minimum-maximum).

DISCUSSION

This study examined the effects of coloring and drawing-based learning strategies on student success in anatomy education. The findings showed that students who used these methods had statistically significantly higher exam scores compared to those who studied with traditional materials alone. The score differences obtained in the subjects of fetal circulation, subclavian and external carotid artery, which are especially supported by painting, are remarkable. In addition, the total formative exam score and the committee general success score also showed significant differences in favor of the coloring method. To date, it has not been shown that a single teaching tool can meet all curriculum requirements (20). The best teaching method for modern anatomy is the use of different pedagogical tools (plastination, CBL, live anatomy, medical imaging, etc.) in a complementary way. Students benefit most from multiple learning models that integrate diverse and system-based methods. The use of a multimodal approach in teaching anatomy is also supported by other anatomists (21,22).

For this reason, it was decided to examine the anatomy coloring methods that are easy to access and low in cost and have recently started to attract attention. Coloring-based learning activities facilitate learning in many ways, such as focusing students' attention, establishing visual connections between concepts, and organizing complex information. Because the generative learning process includes cognitive processes such as selecting, classifying, and integrating information, and each of these processes plays a critical role in making learning permanent (23). It also activates the visual and motor systems simultaneously, allowing information to be actively processed in working memory. Therefore, it can facilitate the transfer of information beyond short-term storage to long-term memory (24).

Quillin and Thomas (25) stated that visual content contributes to the understanding of complex anatomical structures. Wammes and colleagues (26) revealed that visual working memory has a higher capacity than verbal memory and that this allows information to be processed more effectively. Canturitti and colleagues observed in their study that students who colored spent more time and interacted more with the learning material compared to those who did not (27). In the study conducted by HadaviBavili and İlçioğlu (18) with nursing and midwifery students, it was shown that the attitudes towards learning and self-efficacy perceptions of students who participated in coloring activities were positively affected. Although no significant difference was found in the study in terms of exam performance, it was stated that the method was motivating in terms of students' active participation in the learning process. When these studies were evaluated, it was thought that the painting/drawing method contributed to the learning process, but it did not provide objective data. When viewed from this perspective, we can say that this study provided objective data regarding the contribution of the painting/drawing method to learning. Students who used the painting-based learning method showed significantly higher success in both subject-specific and total exam scores compared to those who studied only with traditional materials. Especially in subjects supported by coloring (fetal circulation, subclavian artery, external carotid artery), the difference in success was found to be statistically significant. This situation reveals the effect of multisensory approaches where visual and motor processes are used together in reinforcing learning; it also provides results that are compatible with productive learning models reported in the literature. On the other hand, the fact that no objective measurement was made regarding the current academic levels of the students should be considered as a factor that may limit the generalizability of the comments.

Another important finding of our study is that colored coloring increases students' motivation. The fact that colored images are both aesthetically appealing and prolong students' interaction with the material shows that this method provides indirect but significant contributions to the learning process. Similarly, in their research examining the effectiveness of various learning tools in anatomy education, Davis and colleagues (6) found that students found active methods such as cadaver dissection and small group learning more useful. Students also stated that they acquired knowledge more permanently when they worked with materials that were suitable for their learning styles. These findings support the achievement difference observed in our study pedagogically.

In the study conducted by Chen and his colleagues (28), virtual reality-supported education methods were compared with traditional atlas and cadaver applications; it was seen that the learning outcomes were similar, but the virtual reality application increased the student motivation and interest level. Similarly, painting activities can be considered as low-cost and accessible alternatives that enable the student to actively and meaningfully participate in learning.

Human memory never reaches its maximum capacity (29). Although memory is flexible and infinitely expandable, it is not perfect. We face difficulties in the process of learning to create

strong memories and maintain them effectively (27). People often use visual inputs and mental models to understand and interact with their environment. Instructors can turn this situation to their advantage by using visual aids to reduce cognitive load in the learning process by integrating verbal and visual information (30). According to Keller and Grimm (30) "Information visualizations can reduce unnecessary cognitive load by distributing the cognitive load to different information processing systems using different presentation codes (e.g. verbal, visual, spatial). As a result, the user has more cognitive capacity to manage the learning task (27).

One of the most important contributions of the study is that it reveals the effect of creative methods that ensure active participation of the student in the learning process in fields that contain intensive information load such as medical education on learning outcomes. Thus, it can facilitate not only the memorization of anatomical structures but also their comprehension. Coloring-based learning has the potential to appeal to a wide range of students thanks to its low-cost, accessible and easy-to-apply method. In this respect, it can increase the opportunity to provide quality anatomy education, especially in environments with limited resources.

With this study, it is aimed to provide concrete data on alternative and innovative teaching strategies that can be used in health sciences education, especially in medical schools. The findings will be instructive and guiding in the restructuring of educational programs and the recognition of student-specific learning paths.

One of the strengths of the study is that it was conducted in a real educational environment and the evaluations were based on directly measurable exam performance. However, there are some limitations. The study was observational and the intervention was not structured in a controlled manner; therefore, it is difficult to establish a cause-and-effect relationship. In addition, the sample was from only one university and students from different institutions were not included, which limits generalizability. In addition, since the learning method was self-reported by the students, subjective effects cannot be ignored. In future studies, the effects of coloring-based learning methods on both short-term academic achievement and long-term conceptual integrity can be evaluated using randomized controlled experimental designs. In addition, examining the effects of these methods on self-efficacy, learning style compatibility and motivation will also be beneficial for pedagogical development. In addition, it is recommended to develop more flexible, interactive and individualized learning models with the integration of digital painting platforms.

CONCLUSION

This study has shown that coloring-based learning methods in anatomy education are effective tools with the potential to increase student success. It was determined that students who used painting methods showed significantly higher performance in both subject-specific exam scores and general anatomy success levels. These findings emphasize the positive effect of supplementary techniques that foster student participation and support multi-sensory learning, when used alongside traditional anatomy teaching methods, on learning outcomes. In addition, the fact that female students prefer this method more indicates that learning styles include individual differences and the importance of personalized education approaches. Overall, coloring-based learning can be considered a supportive and accessible tool that enhances traditional teaching, particularly in content-heavy basic science courses. Integrating such approaches in a balanced way may help sustain students' motivation and deepen conceptual understanding.

LIMITATIONS

In this study, students were included in the study on a completely voluntary basis. However, the participants' previous academic success levels and knowledge backgrounds could not be objectively assessed. This situation should be considered as a factor that may create limitations in the interpretation of the obtained data. Moreover, students' preferred learning methods were self-reported, and the study relied on the accuracy and honesty of these statements, which may have introduced a potential source of bias. In future studies, pre-grouping students according to their current success levels and making comparisons between these groups may reveal the effect of the method more accurately.

However, due to the principle of equal opportunity in education, no distinction was made between students according to their level of success within the scope of the current study. Therefore, it is thought that future studies conducted on groups that have received anatomy education but are independent of the formal education process, do not have exam anxiety and are classified according to their level of success will provide more definitive findings about the effectiveness of the method. In addition, studies with extended follow-up periods are needed to evaluate the long-term effects of coloring-based learning. In addition to all these, systematic collection of student feedback can also contribute to the evaluation process by providing qualitative data about the perceived benefit and pedagogical impact of the method.

REFERENCES

1. Pandey P, Zimitat C. Medical students' learning of anatomy: memorisation, understanding and visualisation. Med Educ. 2007;41:7–14.
2. Patel KM, Moxham BJ. The relationships between learning outcomes and methods of teaching anatomy as perceived by professional anatomists. Clin Anat. 2008;21:182–9.
3. Samarakoon L, Fernando T, Rodrigo C. Learning styles and approaches to learning among medical undergraduates and postgraduates. BMC Med Educ. 2013;13:42.
4. Silverberg J, Taylor-Vaisey A, Szalai JP, Tipping J. Lectures, interactive learning, and knowledge retention in continuing medical education. J Contin Educ Health Prof. 1995;15:231–4.
5. Sugand K, Abrahams P, Khurana A. The anatomy of anatomy: A review for its modernization. Anat Sci Educ. 2010;3: 83–93.
6. Davis CR, Bates AS, Ellis H, Roberts AM. Human anatomy: Let the students tell us how to teach. Anat Sci Educ. 2014;7:262–72.
7. Cody J. Painting anatomy on anatomy. J Biocommun. 1995;22:14–7.
8. McMenamin PG. Body painting as a tool in clinical anatomy teaching. Anat Sci Educ. 2008;1:139–44.
9. Op Den Akker JW, Bohnen A, Oudegeest WJ, Hillen B. Giving color to a new curriculum: Bodypaint as a tool in medical education. Clin Anat. 2002;15:356–62.
10. Motoike HK, O'Kane RL, Lenchner E, Haspel C. Clay modeling as a method to learn human muscles: A community college study. Anat Sci Educ. 2009;2:19–23.
11. Waters JR, Van Meter P, Perrotti W, et al. Human clay models versus cat dissection: How the similarity between the classroom and the exam affects student performance. Am J Physiol - Adv Physiol Educ. 2011;35:227–36.
12. Kinnison T, Forrest ND, Frean SP, Baillie S. Teaching bovine abdominal anatomy: Use of a haptic simulator. Anat Sci Educ. 2009;2:280–5.
13. Preece D, Williams SB, Lam R, Weller R. "Let's Get Physical": Advantages of a physical model over 3D computer models and textbooks in learning imaging anatomy. Anat Sci Educ. 2013;6:216–24.
14. Nicholson DT, Chalk C, Funnell WRJ, Daniel SJ. Can virtual reality improve anatomy education? A randomised controlled study of a computer-generated three-dimensional anatomical ear model. Med Educ. 2006;40:1081–7.
15. Petersson H, Sinkvist D, Wang C, Smedby Ö. Web-based interactive 3D visualization as a tool for improved anatomy learning. Anat Sci Educ. 2009;2:61–8.
16. Trelease RB, Rosset A. Transforming clinical imaging data for virtual reality learning objects. Anat Sci Educ. 2008;1:50–5.
17. Wang LL, Wu HH, Bilici N, Tenney-Soeiro R. Gunner goggles: Implementing augmented reality into medical education. In: Studies in Health Technology and Informatics. Vol 220. IOS Press Ebooks, 2016; 446–49.
18. HadaviBavili P, İlçioğlu K. Artwork in anatomy education: A way to improve undergraduate students' self-efficacy and attitude. Anat Sci Educ. 2024;17:66–76.
19. Azer SA. The place of surface anatomy in the medical literature and undergraduate anatomy textbooks. Anat Sci Educ. 2013;6:415–32.
20. Kerby J, Shukur ZN, Shalhoub J. The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students. Clin Anat. 2011;24:489–97.
21. Biassuto SN, Caussa LI, Criado del Río LE. Teaching anatomy: Cadavers vs. computers? Ann Anat. 2006;188:187–90.
22. Rizzolo LJ, Rando WC, O'brien MK, et al. Design, implementation, and evaluation of an innovative anatomy course. Anat Sci Educ. 2010;3:109–20.
23. Wu SPW, Rau MA. How Students Learn Content in Science, Technology, Engineering, and Mathematics (STEM) Through Drawing Activities. Educational Psychology Review. 2019;31: 87–120.
24. Cashdollar N, Duncan JS, Duzel E. Challenging the classical distinction between long-term and short-term memory: Reconsidering the role of the hippocampus. Future Neurology. 2011;6:351–62.
25. Quillin K, Thomas S. Drawing-to-learn: A framework for using drawings to promote model-based reasoning in biology. CBE Life Sci Educ. 2015;14:es2.
26. Wammes JD, Meade ME, Fernandes MA. The drawing effect: Evidence for reliable and robust memory benefits in free recall. Q J Exp Psychol. 2016;69:1752–76.
27. Cantarutti JFM. The Cognitive & Educational Implications of Color Use in Drawing to Learn. Ph.D. thesis, College of Arts&-Sciences of William & Mary; Williamsburg, Virginia, 2022.
28. Chen S, Zhu J, Cheng C, et al. Can virtual reality improve traditional anatomy education programmes? A mixed-methods study on the use of a 3D skull model. BMC Med Educ. 2020;20:395.
29. Kolodner JL. Reconstructive memory: A computer model. Cogn Sci. 1983;7:281–328.
30. Keller T, Grimm M. The impact of dimensionality and color coding of information visualizations on knowledge acquisition. In: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). Vol 3426 LNCS. Springer,Berlin,Heidelberg, 2005;167-182.