"The fall of anatomy": An analysis of anatomy exam results at the University of Split School of Medicine over a ten-year period

Prof. Ivica Grković, M.D., Ph.D.
University of Split School of Medicine, Split, Croatia
E-mail: ivica.grkovic@mefst.hr
ORCID: 0000-0001-9010-2091

Mirko Armanda, medical student
University of Split School of Medicine, Split, Croatia
E-mail: armandamirko02@gmail.com
ORCID: 0009-0005-9476-2181

Summary

The anatomy exam at the University of Split School of Medicine includes a written, practical, and oral components, as well as daily written knowledge checks, known as quizzes. The final grade is the sum of various weighted exam components, and students are allowed five attempts to take the exam during an academic year. The analysis of exam results over a ten-year period, from the academic year 2013/2014 to the academic year 2022/2023, has revealed a downward trend in the overall passing rate of the anatomy exam, as well as a downward trend in average scores for each component of the exam, except for the practical exam. Trends in average values of achieved positive scores for all exam components are presented separately for the first exam term and for the total scores of all exam terms in a given academic year. The most pronounced constant negative trend has been observed for quizzes, while the written and oral components of the exam show a somewhat sharper decline in the first exam period, compared to overall success. By increasing the weighting ratio of quizzes in the final grade, an attempt will be made to change the student perception of their importance and benefits, as a form of continuous assessment.

Ključne riječi: anatomy, exam, quizzes, trends, success

„Pad anatomije": analiza ispitnih rezultata iz anatomije na Medicinskom fakultetu Sveučilišta u Splitu u desetogodišnjem razdoblju

Sažetak

Ispit iz anatomije na Medicinskom fakultetu Sveučilišta u Splitu uključuje pisani, praktični i usmeni dio, kao i dnevne pisane provjere znanja, tzv. kvizove. Konačna ocjena je zbroj različito ponderiranih dijelova ispita, a studenti tijekom jedne akademske godine imaju pravo na pet pokušaja polaganja ispita. Analizom rezultata ispita kroz desetogodišnje razdoblje, od akademske godine 2013./2014. do akademske godine 2022./2023., utvrđen je silazni trend ukupne prolaznosti na ispitu iz anatomije, kao i silazni trend prosječnih rezultata za svaku komponentu, ispita osim za praktični ispit. Trendovi prosječnih vrijednosti ostvarenih pozitivnih rezultata svih ispitnih komponenti prikazani su odvojeno za prvi ispitni rok i za zbirne rezultate svih ispitnih rokova u jednoj akademskoj godini. Najizraženiji stalni negativni trend uočen je za kvizove, a pisana i usmena komponenta ispita pokazuju nešto oštriji pad u prvom ispitnom roku u usporedbi s ukupnom uspješnošću. Povećanjem težinskog omjera kojim kvizovi sudjeluju u završnoj ocjeni pokušati će se promijeniti percepcija njihove važnosti i koristi za studente, kao vida kontinuiranog vrednovanja.

Keywords: anatomy, exam, quizzes, trends, success

1. Introduction

One of the most common questions that academic staff members involved in anatomy teaching at medical schools ask each other, on almost every occasion, is: "How are the students doing this year? Are they interested in the classes? What is the passing rate like?" The discussion triggered by these questions usually includes an almost painful facial expression with a simultaneous comparison with previous generations of students and most often ends with the conclusion that "students are simply not as good as they used to be, even until recently!" To what extent is this conclusion the result of general impressions and sporadic observations, i.e. whether this opinion is based on the results of even a brief analysis, most often remains unknown. The size, complexity and numerous specifics of the course "Anatomy", including that it is placed in the first year of study as well as that it represents the first "medical" course, leads to the fact that we all regularly remember "our anatomy", to which we associate numerous experiences, stories and anecdotes (1). Taking an anatomy exam is a form of "baptism by fire" in medical studies, and passing anatomy is (rightly) seen as a necessary "pass" to continue studies. Exams and other types of student achievement evaluations in modern university studies today in the 21st century is understood as objectively generated indicators that show whether students have achieved the intended learning outcomes of a particular course, in the form of acquired knowledge, skills, competencies and attitudes (2,3). Aligning the curriculum and teaching methods with learning outcomes, as well as checking their adoption, aims to build a correct perception of anatomy: from the widespread initial impression that it is a course whose goal is to memorize a large number of anatomical terms to a course that is primarily based on a conceptual understanding of the organization of body structures, the purpose of which is optimal functioning (4-6). In addition to teaching activities focused on understanding anatomy, the formation of the correct attitude towards anatomy is most quickly achieved by introducing daily testing of knowledge and understanding in the form of mini-exams (so-called quizzes) that are conducted at the end of daily teaching obligations (7). The optimal ratio of testing of factual and conceptual knowledge and understanding in the aforementioned, formative form of quizzes motivates learning, provides feedback on progress, creates opportunities for self-assessment, and becomes an important tool for maintaining and strengthening continuity in work (6). This type of knowledge testing was introduced at the "Anatomy" course for medical students at the University of Split School of Medicine in 2008 and has been continuously implemented since then, as it immediately demonstrated a significant positive educational effect after its introduction (8). In addition to the continuous testing of knowledge that is conducted daily during the anatomical teaching block (course), the anatomy exam at the University of Split School of Medicine also includes a classic, so-called summative form of knowledge assessment, in the form of written exams at the middle and end of the teaching block consisting of multiple choice questions (one correct answer and extended matching types), better known as multiple choice questions type exams (MCQs). In addition to the written parts of the exam, the anatomy knowledge assessment includes a practical exam that involeves recognizing and naming 25 different anatomical structures, and finally an oral exam based on exam cards with seven questions each. The written, practical and oral parts of the exam are held at the end of the course, as well as at all subsequent exam dates. All exam parts are evaluated differently, and the final (passing) grade in anatomy is calculated only when the results of all parts of the knowledge assessment (except quizzes) reach the minimum passing threshold.

In the last 15 years (including the "COVID-19 generations"), neither the format nor the structure of the exam components have been changed, which allows us to not only to precisely determine the overall success/pass rate on the exam, buta also the success trends for each individual exam component within each generation, as well as inter-generational comparisons. Intergenerational comparisons provide an overview of success trends that we try to identify and explain.

The main objectives of the work include a clear presentation of the trend of overall pass rates on the anatomy exam over a ten-year period, as well as an answer to the question of how individual exam components affect the pass rate trend. By analyzing the entire educational process, which certainly includes preparation for the exam, the trends found and the connections between them are attempted to be explained.

2. Methods

This research received a positive opinion from the Ethics Committee of the University of Split School of Medicine (Reg. No.: 2181-198-03-04-25-0038). The number of students whose exam results were analyzed in the observed ten-year period was between 98 and 109 students per generation.i.

2.1. Specific features of the curriculum and format of knowledge assessment

The anatomy course for the study of medicine at the University of Split School of Medicine takes place over 15 weeks, includes 220 teaching hours divided into 39 rounded teaching units. All details of the form and content of the curriculum are publicly available on the website of the Department of Anatomy: https://mefst.unist.hr/nastava/katedre/anatomija-633/633.

Knowledge assessment is carried out continuously by administering 38 short written exams (quizzes) at the end of each teaching unit, except the last one. Each quiz contains 10 questions that are never MCQ type, most often it is about connecting/pairing concepts as well as recognizing correct or incorrect statements and their functional links. In addition to this continuous knowledge assessment, at the end of the teaching block a final knowledge assessment (exam) is conducted, which has a written, practical and oral part, and the condition for access to individual parts of the exam is passing the previous part, starting with the written exam. The "Regulations of studying" at the University of Split School of Medicine stipulate four exam periods, and by meeting special conditions, it is regularly allowed to sit the so-called "dean's exam term" during which an exam can be taken in only one failed subject.

The final grade on the anatomy exam is made up of four parts of varying percentage representation: continuous assessment/quizzes (10%), a written part of the exam consisting of 200 questions (40%), a practical exam consisting of 25 stations where candidates recognize and correctly name marked anatomical structures (20%), and an oral part with seven theoretical questions (30%). Test repository, the so-called the "test bank" for the written part of the exam contains about 3,000 questions, and about 100 new questions are added every year. The absolute number of points obtained on the quizzes (out of a possible 280) is converted into a percentage, after the completion of the course, and added to the points obtained on other test components. All details of the form and content of individual parts of the exam are described in detail and are permanently available on the above-mentioned website of the Department of Anatomy.

2.2. Data analysis

Results of each individual component of the exam for 10 academic years, from 2013/2014. to 2022/2023, are shown graphically, and for the purposes of this paper, the performance trends (regression) of individual exam components, as well as the differences between them, were compared using a t-test. The results gained on the 1st exam dates were compared with the total results of all exam terms in individual academic years using a t-test. For each of the trend lines, the value of the coefficient of determination (R2) is shown, as a measure of the representativeness of the regression. The closer R2 is to one, the more representative the downward trend is. For both the first term and all other exam terms, only the results that meet the minimum exam pass threshold are included.

3. Rezults

The overall pass rate results for the anatomy exam for the observed ten-year period show a downward trend (Figure 1).

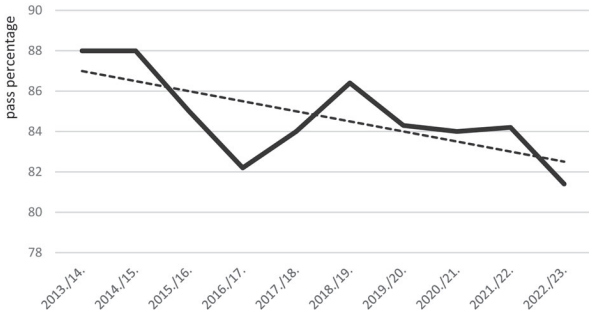

Figure 1. Plot of the relationship between the percentage of passing the anatomy exam for all exam periods (solid line) and the trend line (dashed line), $R^2 = 0.47$. The percentage values on the Y-axis do not start with the value "0" because only passing scores that exceeded the minimum threshold of 60% are included in the plot.

How individual exam components contribute to these trends can be seen when their trends are presented separately.

The presentation of the mean values of the percentage of correct answers in **the written part of the exam** shows a slight decline in the observed period, both in the first exam period and when the passing scores of all exam periods are summed up (Figure 2).

Analysis of the difference in trends in the percentage of correct answers shows that the downward/falling trend in the first exam period is statistically significantly greater than the same trend for all exam periods, p = 0.008.

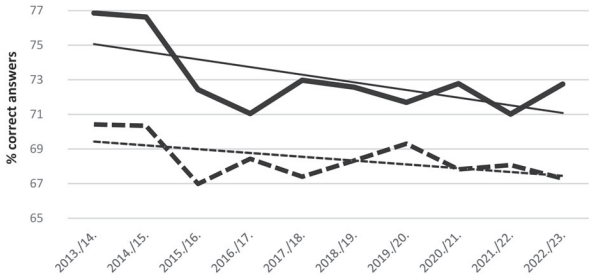

Figure 2. The relationship between the mean values of the percentages of correct answers in **the written part of the exam** for the first exam term (solid line) and the cumulative results for all terms (dashed line). $R^2 = 0.47$ (first exam term), $R^2 = 0.3$ (all terms). The percentage values on the Y-axis do not start with the value "0" because only passing results that exceeded the minimum threshold of 60% are considered for the display.

When the mean results of **continuous knowledge assessment (quizzes)** are shown for students who passed the entire exam in the first term and for the generation as a whole, a significantly more pronounced decline is observed (compared to the declining trend in the written part of the exam) in the observed ten-year period (Figure 3).

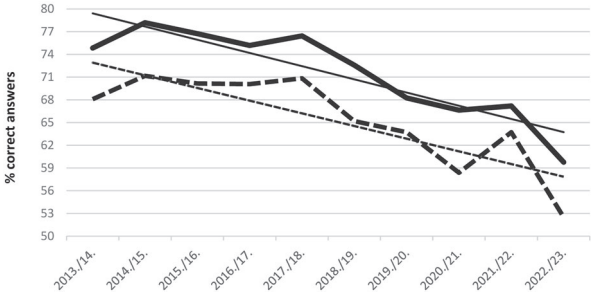

Figure 3. Representation of the relationship between the mean values of the percentages of correct answers in **continuous assessment (quizzes)** for the first exam term (solid line) and the cumulative results for all terms (dashed line). $R^2 = 0.8$ (first exam term), $R^2 = 0.69$ (all terms).

The analysis of the difference in trends shows that there is no statistically significant difference between them, (p = 0.544) indicating an almost identical tendency of the results with the expected difference in the absolute values of the achieved results.

Unlike the written part of the exam and the continuous knowledge assessment, the analysis of the results of **the practical part of the exam** shows completely different trends (Figure 4).

In the first exam term, a mild upward trend in the mean values of the achieved results is observed for this component of the exam, while the trend for all exam terms is almost a horizontal line, which is reflected in the extremely small coefficient of determination ($R^2 = 0.02$). When these two trends are compared, it is found that there is a large statistical difference between them (p = 0.0002).

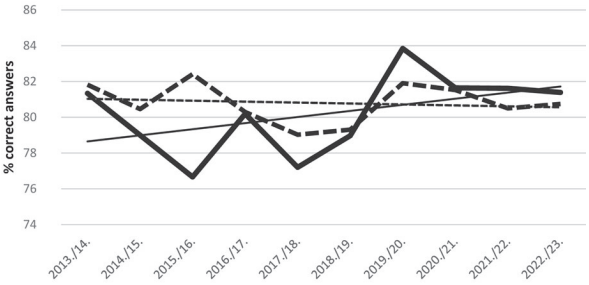

Figure 4. The relationship between the mean values of the percentages of correct answers on **the practical part of the exam** for the first exam term (solid line) and the total results for all terms (dashed line). R^2 = 0.22 (first exam term), R^2 = 0.02 (all terms). The percentage values on the Y-axis do not start with the value "0" because only passing results that exceeded the minimum threshold for this exam component, which is 72%, are shown.

The presentation of the mean values of the results achieved in **the oral part of the exam** shows a slight decline in the observed period (Figure 5), but without a significant difference between the trends (p = 0.87), with the fact that the values in the first term are higher than the same for all exam terms.

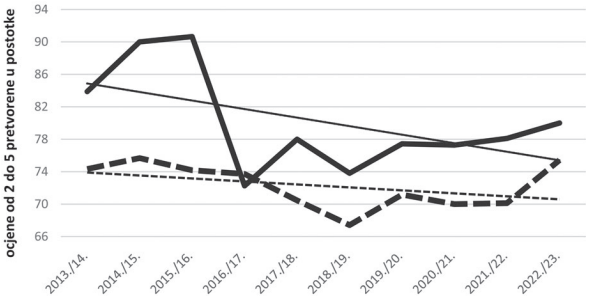

Figure 5. Representation of the relationship between the mean values of the percentages of success in **the oral part of the exam** for the first exam term (solid line) and the cumulative results for all terms (dashed line). R^2 = 0.26 (first exam period), R^2 = 0.16 (all terms).

4. Discussion

The results of our analysis of trends in success (or failure) in the anatomy exam add an objective dimension to the impressions mentioned in the introduction to this paper: that students are continuously achieving poorer results in the anatomy exam. The overall pass rate in the anatomy exam (across all exam dates), despite significant inter-generational variability, is in a noticeable and significant decline, from 88% in the academic years 2013/2014 and 2014/2015 to 77.9% in the academic year 2023/2024, when it was recorded, for the first time, that more than 20% of students from one generation failed and had to "repeat" the subject.

In the ten-year period covered by the analysis, there were no significant changes in the timetable or curriculum, nor changes in the format or content of the exam, which makes credible our conclusion that the success of mastering the anatomy course decreases over time, from generation to generation.

The literature search resulted in finding only one study in which the success of the anatomy exam was monitored over a ten-year period (from 2011 to 2022), but with constant significant changes in the curriculum and the format of the knowledge assessment/exam (9). In this study, it was found that the results for 2013, 2014, and also for 2020 were significantly better than the results for all other years. An alarming decline in the ability to recognize anatomical structures related to the extent of time since attending/passing anatomy has been described for both students and young doctors, but an intergenerational comparison has not been made (10).

Since detailed records are kept for each individual exam component of all exam terms at the Department of Anatomy, we were able to analyze the success trends of individual exam components and thus determine the importance of their contribution to the observed trend of declining pass rates. In order to obtain a more complete picture, a graphic representation of the mean values of the results of the first exam period and the total pass results for each academic year was created, as well as a comparison of the trends for those representations. It was observed that the most pronounced downward trend is present for continuous assessments (quizzes), followed by a somewhat milder downward trend related to the written part of the exam, and then

for the oral part of the exam, while a completely different trend was observed for the practical component of the exam.

Different exam components contribute to the final exam grade by different percentages, the results of continuous knowledge assessment (quizzes), which recorded the strongest downward trend, make up only 10% of the final grade. Unlike the written and practical exams, for which there are minimum score thresholds for passing and meeting the criteria for being able to sit the next exam component, there are no thresholds or conditions for quizzes. The main reasons for introducing continuous assessment in the form of quizzes into the curriculum in the academic year 2007/2008 were highlighted in the introductory part of this paper, with the intention of introducing a formative dimension to knowledge assessment, to accelerate the shift in students' approach to anatomy: from "superficial" (which involves only the mere memorization of anatomical facts) to "deep" (which implies a continuous effort to understand and functionally connect learned anatomical facts) (8,11,12). It seems that, regardless of the effort we constantly put in improving the formative dimension of questions on quizzes, we are not managing to make progress, which is reflected in the most pronounced downward trend for quizzes. The fact that they are "worth" only 10% of the total grade certainly does not contribute to appreciation of the importance of quizzes in the process of evaluating student work. Therefore, we decided to change the structure of the weighting system of grades in academic year 2024/2025 and equalize the percentage contributions of quizzes, practical and oral part of the exam to 20% of the total grade. It remains to be determined by some future analysis how this change will be reflected in the overall exam results.

A significantly milder, but constant decline is also present in the written part of the exam, which is, in terms of the share in the final grade, the "most valuable" exam component. The written part of the exam consists of 200 MCQ-type questions weighted evenly across the material so that all topics are equally represented on the exam. 140 questions are of the simplest form: with one correct/incorrect answer out of five offered, and in 60 questions, points are awarded correct selection of combinations of correct answers (out of four offered). In addition to this, when composing the written part of the exam, care is taken to ensure equal representation of questions that test conceptual and factual knowledge of anatomy. The above rules for composing the exam are a proven way of standardizing the written part of the exam (12). The exam repository, the so-called the "exam bank" for the written part of the exam at the Department of Anatomy is regularly updated with new questions, with between 100 and 200 new questions being added to the bank each academic year, and new written exams are created for each exam period using the format described above. We believe that this is the only way to influence the (increasingly widespread) student practice of preparing for the written part of the exam by studying (actually memorizing) questions from numerous, widespread and easily accessible student repositories of exam questions. In the mid-1980s, this approach to exam preparation received an official name, and in addition to the categories of the already mentioned superficial and deep learning approaches, the so-called "strategic" type of exam preparation was introduced, in which most of the time spent preparing for the exam is focused on studying/memorising versions of previous exam questions or entire exams, all in the hope that they will be repeated in the upcoming exam period (13). It would be interesting to determine how long the "half-life" of new exam questions is, i.e. the "transfer" time from the official, anatomical bank to student repositories. It seems that this time, with all the available technology, is getting shorter every year, so that most new questions manage to be reconstructed during one academic year. Since the bank is refreshed with new questions during the duration of teaching block and that the majority of new questions appear in the first exam period, this may be one of the explanations for the stronger downward trend in the first exam period compared to the trend of all terms. After the first exam period,

new questions don't fall into "never seen" category! Based on direct teaching experiences, we can determine a trans-generational deficit, i.e. a decline in enthusiasm (sometimes even indifference) among a large number of students, despite the truly exceptional efforts of most teachers and associates at the department. This is reflected in the (almost measurable) active resistance to the deep learning approach (14), and we are free to note that every year there is an increasing number of students who practice a combination of superficial and "strategic" approaches to exam preparation. It seems that one way to change the trend for the written part of the exam, from descending to ascending, could be to stop refreshing the question bank! As for the practical part of the exam, the upward trend in the first exam term is the result of the fact that the practical part of the exam in this term is taken mainly by students who manage to pass the written part of the exam in the form of partial exams during the teaching shift. The format and content of this exam component have changed minimally over the years, and it is about assessing the ability to recognize and correctly name selected anatomical structures, which is well standardized (15), so students do not have major problems with this component, after passing the written part of the exam. Before each exam term, students are assigned individual work sessions in the anatomy dissection room where they have the opportunity to interact with anatomical specimens used in the practical exam, from radiographs, bone and joint preparations, plastic organ models as well as wet speciments and cadavers. In this exam component as well, the "strategic" approach to preparation resulted in the creation of a broad list of all structures that appear "more frequently" on the exam, which serves as a fairly high-quality guide for students in preparing for the exam. Therefore, "surprises" are rare in this component, and the results are consistent. In the last few years, we have noticed a marked selectivity in the preparations for the exam, i.e. its components, so that it is rare for a student to pass both the written and practical exams on the single exam term. Since by passing the written part of the exam, students gain the right to take the practical exam in the same exam term, they regularly use this right but most often fail to pass, because they do not have time to prepare for the practical part of the exam. This, although certainly affecting the overall pass rate, does not cause a negative trend for this exam component.

In order to reduce the anxiety and worry that is regularly associated with the oral part of the anatomy exam and to increase objectivity and uniformity (5), exam cards containing seven questions each were introduced into the oral exam even before quizzes were introduced into the curriculum. Although all the questions on the cards were publicly announced, and the "strategic" approach to preparation for this exam component also led to the creation of a (popular) text containing short versions of the answers to these questions, an analysis of this exam component still shows a slight downward trend. Although the percentage of positive grades (from 2-sufficent to 5-excellent) awarded in the oral part of the exam is on average higher in the first exam period, when the best students of a generation take the exam, the trans-generational downward trend is more pronounced for the same, indicating a decrease in the number of students who received high, very good and excellent grades in the oral part of the first term.

Ultimately, it seems that all exam components, except for the practical part of the exam, contribute to the overall downward trend in the success rate on the anatomy exam, and since they have different weighting averages in the final grade (from 10 to 40%), the results of the written part of the exam have the most pronounced impact on the downward trend in the overall passing rate. It will be interesting to see in the next few years how our "intervention" of increasing the weighting ratio of quizzes from 10 to 20% (at the expense of reducing it in the oral part of the exam from 30 to 20%) will affect the overall results. The main reason for this intervention in weighting ratios is to give greater importance to continuous assessment through which, by focusing on testing clearly defined learning outcomes, a deep approach

to mastering anatomy material is encouraged during the course (5). It remains to be seen whether we will succeed in this.

5. Conclusion

We believe that it would be quite usefull if there were available data on the exams and the success of passing all subjects/courses, both preclinical and clinical, at all medical faculties in Croatia, which would be visible in the annual reports on the teaching activities of individual faculties. Such data are usually quite rare, but without their publication and analysis, it is impossible to introduce improvements (16). The first, true step in this direction is the presentation of data on the passing rate in the first examination terms for all subjects of all study programs at the University of Split School of Medicine in the academic year 2023/2024. The presentation of the data was held at the Faculty Council session in October 2024, and the data were sent to the members of the Faculty Council for their information. According to these data, Anatomy has by far the lowest passing rate in the first examination term, with 33.7% for the medical course in Croatian language and 22.8% for the medical course in the English language. In contrast, a large number of subjects, especially clinical subjects, have a first-term pass rate of between 90 and 100%. The results of this analysis suggest that a “strategic” approach to exam preparation is perhaps very well developed in many clinical subjects.

References

1. Sugand K, Abrahams P, Khurana A. The anatomy of anatomy: a review for its modernization. Anat Sci Educ. 2010;3(2):83–93. doi: 10.1002/ase.139.
2. Eldred E, Eldred B. Supply and demand for faculty in anatomy. J Med Educ. 1961;36:134–147.
3. Bergman EM, Verheijen IW, Scherpbier AJ, Van der Vleuten CP, De Bruin AB. Influences on anatomical knowledge: The complete arguments. Clin Anat. 2014;27(3):296–303. doi: 10.1002/ca.22341.
4. Bergman EM, Prince KJ, Drukker J, van der Vleuten CP, Scherpbier AJ. How much anatomy is enough? Anat Sci Educ. 2008;1(4):184–188. doi: 10.1002/ase.35.
5. Brenner E, Chirculescu ARM, Reblet C, Smith C. Assessment in anatomy. Eur J Anat. 2015;19(1):105–124.
6. Miller SA, Perrotti W, Silverthorn DU, Dalley AF, Rarey KE. From college to clinic: reasoning over memorization is key for understanding anatomy. Anat Rec. 2002;269(2):69–80. doi: 10.1002/ar.10071.
7. Evans DJ, Zeun P, Stanier RA. Motivating student learning using a formative assessment journey. J Anat. 2014;224(3):296–303. doi: 10.1111/joa.12117.
8. Poljicanin A, Caric A, Vilovic K, Kosta V, Marinovic Guic M, Aljinovic J et al. Daily mini quizzes as means for improving student performance in anatomy course. Cro Med J. 2009;50(1):55–60. doi: 10.3325/cmj.2009.50.55.
9. Briston CA. Ten Years in the human anatomy and physiology I classroom: A retrospective analysis of student preparation, engagement, performance, and the impact of COVID-19. HAPS Educator. 2022;26(2):19–36. doi: 10.21692/haps.2022.010.
10. Holda MK, Stefura T, Koziej M, Skomarovska O, Jasinska KA, Salabun W et al. Alarming decline in recognition of anatomical structures amongst medical students and physicians. Ann Anat. 2019;221:48–56. doi: 10.1016/j.aanat.2018.09.004.
11. Mattick K, Knight L. High-quality learning: harder to achieve than we think? Med Educ. 2007;41(7):638–644. doi: 10.1111/j.1365-2923.2007.02783.x.
12. Koppes DM, Triepels CPR, Notten KJB, Smeets CFA, Kruitwagen R, Van Gorp T et al. The Level of Anatomical Knowledge, Hard to Establish: a Systematic Narrative Review. Med Sci Educ. 2022;32(2):569–581. doi: 10.1007/s40670-022-01509-w.
13. Newble DI, Entwistle NJ. Learning styles and approaches: implications for medical education. Med Educ. 1986;20(3):162–175. doi: 10.1111/j.1365-2923.1986.tb01163.x.
14. Odontides L, Scheiter K, Shiozawa T, Fischer MR, Kugelmann D, Berndt M. Influence of learning strategies and motivation on anatomy test performance of undergraduate medical students. Ann Anat. 2024;256:152320. doi: 10.1016/j.aanat.2024.152320.
15. Yaqinuddin A, Zafar M, Ikram MF, Ganguly P. What is an objective structured practical examination in anatomy? Anat Sci Educ. 2013;6(2):125–133. doi: 10.1002/ase.1305.
16. Fowell SL, Southgate LJ, Bligh JG. Evaluating assessment: the missing link? Med Educ. 1999;33(4):276–281. doi: 10.1046/j.1365-2923.1999.00405.x.