

# Implementing Formative Assessment in Human Anatomy Practical Sessions: Medical Students' Perception and Effect on Final Exam Performance

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**Background:** Formative assessment with feedback is part of the assessment program in medical education to improve students' learning. Limited research has focused on its application and impact on practical anatomy education.

**Methods:** This study aimed to examine medical students' perceptions of formative assessment in practical anatomy sessions of body systems-based educational units and explore its influence on final practical exam performance. A descriptive, cross-sectional study was conducted. Data was collected from 173 Year 2 medical students through a survey that addressed their perception of process and importance of formative assessment and feedback. The survey employed a 5-point Likert scale. Two open-ended questions were appended at the end of the survey. Students' performance in Unit 3 (where formative assessment was conducted) was compared to their performance in Unit 2 (where no formative assessment was conducted) and with the performance of the previous academic year's students in Unit 3 (where no formative assessment was conducted). Descriptive statistics were used. The level of statistical significance was set at p-value < 0.05. Responses to open-ended questions (qualitative data) were counted, categorized as themes, and presented as frequencies and percentages.

**Results:** The survey showed high internal consistency, and its validity was established through exploratory factor analysis. Results showed that the mean mark for the unit with formative assessment and feedback was significantly higher than for the units without formative assessment and feedback. Students showed positive perception of formative assessment and feedback conducted after practical anatomy sessions. They reported useful insights regarding the benefits they gained from formative assessment and feedback as well as constructive suggestions for future improvements.

**Conclusion:** The study indicates that students positively perceived formative assessment and feedback sessions after practical anatomy sessions. Findings also refer to a positive effect of formative assessment on students' performance in summative practical assessment in anatomy.

**Keywords:** anatomy education, anatomy practical sessions, formative assessment, feedback, exam performance

## Introduction

Anatomy is one of the fundamental subjects in the medical curriculum. Teaching anatomy helps medical students to understand the intricate structural organization of the body, and hence is essential for diagnosis and treatment of medical conditions and performing surgical procedures.<sup>1,2</sup> It was indicated in the literature that learning anatomy through the constructivist approach is the most beneficial,<sup>3,4</sup> where students are actively involved in their learning during practical anatomy lessons. Assessing students' proficiency and comprehension of anatomy is commonly done through practical exams, which require the identification of anatomical structures and understanding their relationships.<sup>5-7</sup>

Student assessment is an important part of medical education that plays a pivotal role in shaping the student's academic journey. It refers to judging the learner's performance based on specific learning objectives.<sup>8–10</sup> There are two main types of assessments: summative assessment and formative assessment. An assessment that is done after the course is completed and gives a judgement about the learning is called a summative assessment (assessment of learning), whereas the assessment that is done during the course of instruction is called a formative assessment (assessment for learning).<sup>9,11–14</sup>

Formative assessment with feedback is being increasingly emphasized as part of the assessment program in medical education in order to improve students' learning on subject matters.<sup>15–18</sup> In anatomy courses, formative assessments are mainly used as an important tool to measure learning throughout the course. Such assessments improved student subject mastery and exam performance.<sup>19</sup> Furthermore, repeated testing with feedback results in significantly greater long-term retention of information than repeated, spaced studying.<sup>20</sup> Feedback is most effective when formative assessment is available early in the learning process.<sup>10,13,14</sup> In addition, formative assessment makes the teachers and instructors aware of the student's progress and areas of difficulty so that they are better able to make the required instructional adjustments, such as reteaching, which improves student accomplishment.<sup>21</sup>

Feedback given to students as part of formative assessment helps them detect any gaps between the intended goals and their current knowledge and guides them to take the appropriate strategic measures to accomplish their goal. This enhances their metacognitive abilities, enabling them to be more self-aware, self-reliant, and to concentrate more on their areas of weakness.<sup>10,21,22</sup> Effective feedback must encourage students, include specific suggestions for improvement, motivate the students to learn to reach higher levels, and counteract the liability of students to become discouraged and unable to learn.<sup>23–26</sup>

Despite the growing recognition of the importance of formative assessment and its potential benefits in medical education, limited research has focused on its application and impact in the domain of anatomy education. This research study addressed this gap by examining medical students' perception of formative assessment in anatomy and exploring its potential influence on their final practical exam performance. By investigating students' attitudes, experiences, and perceptions regarding the implementation of formative assessment strategies, we can gain valuable insights into its effectiveness and identify areas for improvement in anatomy education.

Hence, this study aimed to explore medical students' perceptions of formative assessment and feedback sessions conducted after practical anatomy sessions. In addition, it aimed to compare their performance in the summative assessment of educational units that had formative assessment with their performance in the summative assessment of educational units that did not have formative assessment.

## Materials and Methods

### Study Design

This is a descriptive, cross-sectional study aiming at exploring the perceptions of the 2<sup>nd</sup> year medical students of the formative assessment in practical anatomy sessions and explore the effect of such formative assessment on their performance in summative exams in anatomy.

### Sampling and Sample Size

A comprehensive sampling technique (complete enumeration) was employed, where all second-year medical students were approached. One hundred seventy-three male and female students responded to the survey and their summative practical exam results were analyzed (n=173).

### Context

The College of Medicine and Medical Sciences, Arabian Gulf University (CMMS-AGU) follows an innovative problem-based learning integrated curriculum built around the body systems (respiratory system, cardiovascular system, urinary system ... etc.) In the human anatomy lab at the CMMS-AGU, a novel method called Checklist-based Active Learning of Anatomy Demonstration Sessions (CALADS) is used, where the students actively learn anatomy in groups guided by a checklist containing all the anatomical parts and details they should study.<sup>27</sup> Students are divided into groups of 20–25

and undergo comprehensive training on various types of specimens (cadaveric specimens, plastinated models, plastic models, and radiological anatomy films, as well as histology slides). This hands-on training allows students to explore and understand the intricate details of human anatomy, fostering a deep understanding of human anatomy. Starting from the academic year 2022–2023, an initiative to implement formative assessment after practical sessions was approved by the anatomy department. It started from the third educational unit. In this initiative, a formative assessment is conducted to assess students' anatomical knowledge and practical skills directly after each training session is over. This assessment focuses on the material learned during the practical session and takes the form of Objective Structured Practical Examination (OSPE) stations, where students rotate through different stations to demonstrate their proficiency in anatomical identification, dissection techniques, and application of theoretical concepts. Immediately after formative assessments, students engage in feedback sessions with their same assigned tutors. Tutors provide constructive feedback to the students based on their performance in formative assessments, discussing areas of strength and areas that need improvement. This feedback aims to guide students towards further development, enhancing their understanding and competence in human anatomy. Through this iterative process of training, assessment, and feedback, students are actively supported in their learning journey, enabling them to refine their anatomical knowledge and skills. The process is illustrated in Figure 1.

At the end of the unit, summative assessment of students' practical anatomy skills is conducted (end-of-unit exam). This summative assessment takes the form of OSPE similar to the one they had as a formative assessment.

## Instrument and Data Collection

Data on students' perceptions was collected through a self-administered survey form that was drafted by the researchers after reviewing the relevant literature and similar studies. The survey was revised by experts in medical education and anatomy, and necessary changes were made based on their revision. The survey consisted of 12 items that address the perception of the students of the process and importance of formative assessment and feedback. The survey employed a 5-point Likert scale that ranged from 5 (Strongly Agree) to 1 (Strongly Disagree).

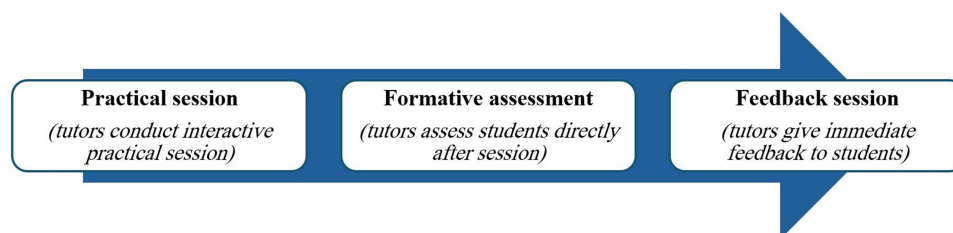
The reliability of the survey was tested through Cronbach's alpha test, while the construct validity was established through exploratory factor analysis (EFA).

In addition, two open-ended questions were appended at the end of the survey form. The two questions were: "What are the main benefits you gained from formative assessment and feedback sessions?" and "What are your suggestions to improve formative assessments and feedback sessions?"

The survey was distributed to students after the formative assessment and feedback sessions.

Students' performance in the Respiratory System (RS) unit (Unit 2, where they had no formative assessment and feedback sessions) and the Cardiovascular System (CVS) unit (Unit 3, where they had formative assessment and feedback sessions) were compared.

Moreover, their performance in Unit 3 (CVS) was compared to the performance of previous academic year's students (as a control group) who were not exposed to any formative assessment and feedback in their Unit 3 (CVS). Comparability of the demographic characteristics of the students in those two groups is reassured by the fact that students in both academic years were admitted to the medical program based on the same admission criteria and they were taught and assessed by the same teachers using the same methods in a consistent manner over the two years.



**Figure 1** Flow of events: practical session-formative assessment-feedback session.

## Statistical Analysis

Data was analyzed by IBM SPSS v.25.0 software. Descriptive statistics were used, and the quantitative data was presented in the form of means and standard deviations. Demographic data was presented as percentages. Responses to open-ended questions (qualitative data) were counted, categorized by the authors as themes, and presented in the form of frequencies and percentages. Quotes by the students were aligned with the themes based on the common keywords and the overall meaning. Comparison between the mean marks of the same students in the two different units was done through paired samples *t*-tests, while independent *t*-test was used to compare different groups of students as well as male and female students' perceptions. The level of statistical significance was set at  $p < 0.05$ .

Principal component analysis was used in EFA. The number of factors extracted and used was based on the Kaiser criterion, where factors with an eigenvalue  $>1$  are considered as common factors,<sup>28</sup> the Scree test criterion (the Cattell criterion) to identify the inflexion point indicated by the Scree plot,<sup>29</sup> and the cumulative percentage of variance extracted.<sup>30</sup> Factor solutions were then analyzed based on the following interpretability criteria:<sup>31</sup>

- An accepted factor must contain at least three items with substantial loadings (a loading of 0.30 as the cutoff).
- Items that load on the same factor must have a common conceptual meaning.
- An item that loads on a different factor measures a different construct.

## Ethics Approval and Consent to Participate

The study was approved by the Research and Ethics Committee of the CMMS-AGU (Approval number: E23-PI-5-23). Participants provided informed consent, which included permission for the publication of their responses in an anonymized format. They were informed about the purpose of the study and were given the right to refuse participation without any consequences. Participants' confidentiality was maintained as the survey was provided anonymously.

## Results

The results of this research work are presented in two sections: reliability and validity studies of the survey and analysis of the responses of study participants.

### Section I: Reliability and Validity Studies of the Survey

The reliability study revealed an excellent internal consistency of the survey (Cronbach's  $\alpha = 0.925$ ).

The construct validity of the survey was established through EFA (Table 1 and Figure 2).

Table 1 shows the results of the exploratory factor analysis. The table shows that all items of the survey have loadings on one factor, with item 11 having the highest loading of 0.84. The communalities for all items range from 0.28 to 0.70, indicating that they are well-represented by the factor and may be more reliable. The eigenvalue for the one factor is 6.8, which explains 56.9% of the variance in the data. The overall fit of the model is good, as indicated by a Kaiser-Meyer-Olkin measure of 0.94 and a statistically significant Bartlett's test of sphericity ( $\chi^2 = 1169.02$ ,  $p=0.000$ ). Based on these results, it appears that the factor represents a strong underlying construct, which could be conceptualized as "Student Perception".

Figure 2 shows the scree plot of the EFA. The scree plot shows a clear break at the first factor, indicating that only one factor should be retained. The slope before the scree point is steep, suggesting that the first factor explains the largest portion of the variance in the data.

### Section II: Analysis of Study Participants' Responses

The response rate was 80.5% ( $n=173$ ). Female students constituted about two-thirds of the study sample. Data was collected through a survey prepared by the authors to explore their perception of the formative assessment and feedback introduced at the anatomy practical sessions. Data on student's performance in final anatomy practical exams was obtained from the assessment documents after taking the necessary permissions from the CMMS-AGU administration.

Table 2 indicates that the mean mark for Unit 3 (14.22) (wherein formative assessment was conducted) is higher than that for Unit 2 (11.62) (wherein no formative assessment was conducted). The difference is statistically significant ( $t =$

**Table 1** Exploratory Factor Analysis (EFA) of the Survey

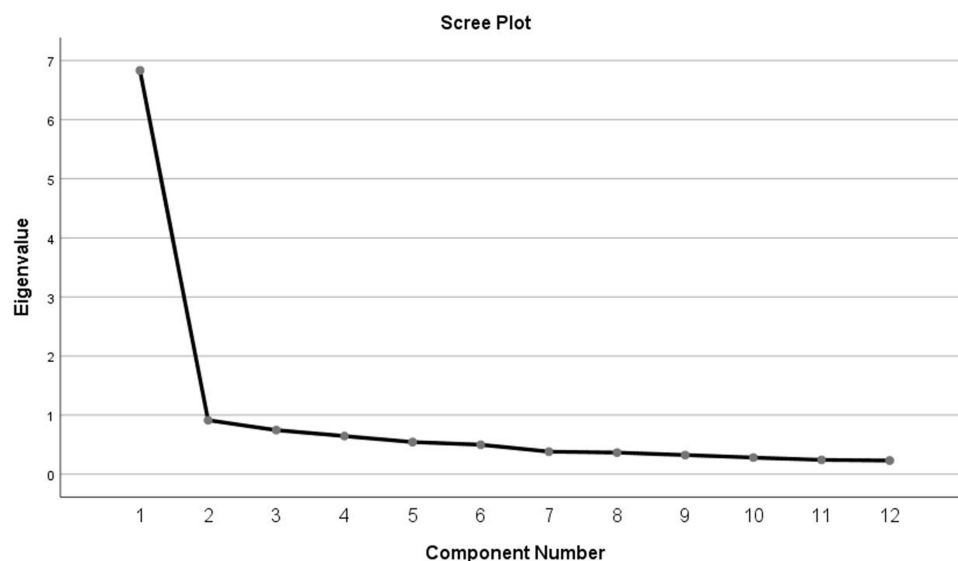
No.*	Item	Factor 1 <sup>‡</sup>	h <sup>2</sup>
11	Overall, formative assessment of practical anatomy has been helpful to my learning experience	0.84	0.70
2	Formative assessments helped me identify my misunderstandings in human anatomy	0.81	0.66
6	Formative assessments helped me identify easily forgettable important details in human anatomy	0.80	0.64
9	Formative assessments helped me prepare for the summative OSPE	0.79	0.62
10	I expect formative assessments to reduce my OSPE exam-related anxiety	0.78	0.62
3	Formative assessments helped me improve my understanding of human anatomy	0.78	0.60
7	Feedback given by the instructors after formative assessments was helpful to my learning experience	0.76	0.57
5	Formative assessments helped me evaluate my knowledge level in human anatomy	0.75	0.57
8	I utilize the feedback from formative assessments to guide my studying for future exams	0.75	0.57
4	I feel confident in my knowledge of human anatomy after completing the formative assessments	0.73	0.53
12	I wish to have formative assessment in upcoming educational units	0.69	0.48
1	Formative assessments in human anatomy match well with the content covered in theoretical and practical sessions	0.53	0.28
Variance (%)		56.9%	
Eigenvalue		6.8	

**Notes:** \*Total final items are 12 items. No items were deleted. Items are sorted from the item with the highest loading to the item with the lowest loading. <sup>‡</sup>Factor label is Factor 1: Student Perception (n=12 items).

**Abbreviation:** h<sup>2</sup>, item communalities.

12.04;  $p = 0.0001$ ). The findings in the table suggest that the formative assessment may have had a significantly positive effect on students' performance.

Table 3 indicates that in the academic year 2023–2024, where formative assessment and feedback were implemented, the average mark in Unit 3 was higher compared to the previous academic year 2022–2023, where formative assessment



**Figure 2** Scree plot of Exploratory Factor Analysis (visually showing eigenvalues plotted against factor numbers to help identify the optimal number of factors to retain in the analysis).

**Table 2** Comparison of Mean Marks in Unit 2 (Without Formative Assessment) and Unit 3 (with Formative Assessment) in the Academic Year 2023–2024 Using Paired Samples *t*-Test

Unit	n	Mean Mark (±SD)	Min – Max (Top mark = 20)	t	Sig. (p-value)
<b>Unit 2 (RS)</b> (No formative assessment and feedback)	173	11.62 (±4.55)	1–20	12.04	0.0001*
<b>Unit 3 (CVS)</b> (With formative assessment and feedback)	173	14.22 (±4.64)	4–20		

\* Statistically significant.

**Table 3** Comparison of Mean Marks in Unit 3 in the Academic Year 2023–2024 (with Formative Assessment) and the Academic Year 2022–2023 (Without Formative Assessment) Using Independent Samples *t*-Test

Unit	n	Mean Mark (±SD)	Min – Max (Top mark = 20)	t	Sig. (p-value)
<b>Unit 3 (CVS; 2022–2023)</b> <sup>‡</sup> (No formative assessment and feedback)	168	12.59 (±5.22)	2–20	3.10	0.002*
<b>Unit 3 (CVS; 2023–2024)</b> (With formative assessment and feedback)	173	14.22 (±4.64)	4–20		

**Notes:** \*Statistically significant. <sup>‡</sup> Marks of the students of the previous academic year were used as a control group for comparison.

and feedback were not implemented. The difference in mean marks between the two groups was found to be statistically significant ( $t = 3.10$ ;  $p = 0.002$ ). This suggests that the introduction of formative assessment and feedback had a positive impact on the students' performance in Unit 3.

Table 4 presents the means and standard deviations of students' responses to a survey regarding their perception of formative assessment and feedback conducted for human anatomy demonstration sessions. The mean scores ranged from

**Table 4** Means and Standard Deviations of Students' Responses Regarding to Their Perception of Formative Assessment and Feedback (n=173)

No.	Item	Mean (±SD)	Min – Max
1	Formative assessments in human anatomy match well with the content covered in theoretical and practical sessions	4.53 (±0.70)	3–5
2	Formative assessments helped me identify my misunderstandings in human anatomy	4.58 (±0.67)	1–5
3	Formative assessments helped me improve my understanding of human anatomy	4.51 (±0.75)	1–5
4	I feel confident in my knowledge of human anatomy after completing the formative assessments	4.35 (±0.78)	1–5
5	Formative assessments helped me evaluate my knowledge level in human anatomy	4.54 (±0.70)	1–5
6	Formative assessments helped me identify easily forgettable important details in human anatomy	4.48 (±0.75)	1–5
7	Feedback given by the instructors after formative assessments was helpful to my learning experience	4.50 (±0.73)	1–5
8	I utilize the feedback from formative assessments to guide my studying for future exams	4.47 (±0.74)	1–5
9	Formative assessments helped me prepare for the summative OSPE	4.42 (±0.81)	1–5
10	I expect formative assessments to reduce my OSPE exam-related anxiety	4.36 (±0.86)	1–5
11	Overall, formative assessment of practical anatomy has been helpful to my learning experience	4.61 (±0.60)	1–5
12	I wish to have formative assessment in upcoming educational units	4.58 (±0.79)	1–5



4.35 to 4.61 out of 5. Item 11 has the highest mean score, indicating that students found formative assessment of practical anatomy to be particularly helpful to their learning experience. Item 4 has the lowest mean score, indicating that students were relatively less confident in their knowledge of human anatomy after completing the formative assessments. Generally, the results suggest that students have a positive perception of formative assessment and feedback conducted during the sessions.

Table 5 presents a comparison between males and females in their perception of formative assessment and feedback in conducted for human anatomy demonstration sessions. The mean scores for males and females are generally similar, with only small differences observed in some items. For example, males have a slightly higher mean score in item 1 (“Formative assessments in human anatomy match well with the content covered in theoretical and practical sessions”), while females have a slightly higher mean score in item 3 (“Formative assessments helped me improve my understanding of human anatomy”). Overall, the results show that there are no statistically significant differences in the perception of formative assessment and feedback between males and females ( $p > 0.05$ ).

Table 6 presents the students’ responses to the open-ended questions about the benefits they gained from the formative assessment and feedback sessions, as well as their suggestions to improve these sessions.

Regarding the benefits of the formative assessment and feedback sessions, the most mentioned benefit, reported by 43.4% of the students, was that the sessions helped them prepare for the final end-of-unit practical exam. Other benefits mentioned by the students included understanding the subject of anatomy and remembering easily forgettable information (27.4%), assessing their knowledge in human anatomy, and identifying their weaknesses (16%), and reviewing what they learned in the practical sessions (8.5%). A smaller percentage of students reported that the sessions helped reduce stress and anxiety related to the summative practical exam (4.7%).

In terms of suggestions to improve the formative assessments and feedback sessions, the most frequently mentioned suggestion, by 43.5% of the students, was to upload questions with explanatory feedback on Moodle for self-review.

**Table 5** Comparison Between Males and Females Regarding Their Perception of Formative Assessment and Feedback

No.	Item	Males (n=52)	Females (n=121)	Sig. (p-value)
		Mean ( $\pm$ SD)	Mean ( $\pm$ SD)	
1	Formative assessments in human anatomy match well with the content covered in theoretical and practical sessions	4.60 ( $\pm$ 0.60)	4.50 ( $\pm$ 0.73)	0.426
2	Formative assessments helped me identify my misunderstandings in human anatomy	4.54 ( $\pm$ 0.64)	4.60 ( $\pm$ 0.68)	0.558
3	Formative assessments helped me improve my understanding of human anatomy	4.42 ( $\pm$ 0.78)	4.55 ( $\pm$ 0.74)	0.328
4	I feel confident in my knowledge of human anatomy after completing the formative assessments	4.33 ( $\pm$ 0.76)	4.36 ( $\pm$ 0.78)	0.825
5	Formative assessments helped me evaluate my knowledge level in human anatomy	4.52 ( $\pm$ 0.67)	4.55 ( $\pm$ 0.72)	0.823
6	Formative assessments helped me identify easily forgettable important details in human anatomy	4.46 ( $\pm$ 0.73)	4.46 ( $\pm$ 0.77)	0.835
7	Feedback given by the instructors after formative assessments was helpful to my learning experience	4.58 ( $\pm$ 0.67)	4.47 ( $\pm$ 0.75)	0.382
8	I utilize the feedback from formative assessments to guide my studying for future exams	4.44 ( $\pm$ 0.75)	4.49 ( $\pm$ 0.73)	0.712
9	Formative assessments helped me prepare for the summative OSPE	4.44 ( $\pm$ 0.75)	4.41 ( $\pm$ 0.83)	0.829
10	I expect formative assessments to reduce my OSPE exam-related anxiety	4.40 ( $\pm$ 0.85)	4.35 ( $\pm$ 0.86)	0.691
11	Overall, formative assessment of practical anatomy has been helpful to my learning experience	4.65 ( $\pm$ 0.56)	4.60 ( $\pm$ 0.61)	0.553
12	I wish to have formative assessment in upcoming educational units	4.52 ( $\pm$ 0.85)	4.60 ( $\pm$ 0.77)	0.524

**Table 6** Frequencies and Percentages of Students' Responses to Open-Ended Questions of the Survey Including Quotes by Students

Question	Response Themes	Response Frequency	Response Percentage	Quotes by Students
<b>What are the main benefits you gained from formative assessment and feedback sessions?</b>	Preparing me for the final end-of-unit OSPE exam	46	43.4%	<i>"I consider the formative assessment and feedback sessions as mock exam that trained me on dealing with the OSPE questions at the end-of-unit exam."</i> <i>"Attending formative assessment sessions gave me deeper understanding of the main anatomical concepts, especially because of the feedback I received from the tutors".</i> <i>"I am happy this assessment reduced my anxiety in the final exam as I now know how the questions come".</i>
	Understanding the subject of anatomy and remembering the easily forgettable information	29	27.4%	
	Assessing my knowledge in human anatomy and knowing my weaknesses	17	16%	
	Reviewing what I learned in the practical sessions	9	8.5%	
	Reducing the stress and anxiety related to the summative practical exam	5	4.7%	
	<b>Total Responses</b>	<b>106</b>	<b>100%</b>	
<b>What are your suggestions to improve formative assessments and feedback sessions?</b>	Uploading questions with explanatory feedback on the learning management system (Moodle) for self-review	20	43.5%	<i>"I think it would be useful if we can have a larger number of review questions on Moodle [LMS] so we can revisit all the time from our homes".</i> <i>"Continue this initiative, but with more questions that cover not only gross anatomy and histology but also embryology".</i>
	Adding more questions to the formative exam	19	41.3%	
	Diversify the types and scopes of questions to also include embryology	4	8.7%	
	Conducting a formative quiz after theoretical teaching session	3	6.5%	
	<b>Total Responses</b>	<b>46</b>	<b>100%</b>	

Other suggestions included adding more questions to the formative exam (41.3%), diversifying the types and scopes of questions to include embryology (8.7%), and conducting a formative quiz after each teaching session (6.5%).

## Discussion

This study explored how medical students perceive the role of formative assessment and feedback in their learning experience as well as the impact of formative assessment and feedback on the performance of those students on the final practical exam. The analysis of the data revealed positive student perceptions as well as significant improvement in students' performance in final practical exam after exposure to formative assessment and feedback sessions.

The findings of our study provide valuable insights into the relationship between formative assessment and feedback and students' performance in final practical anatomy exam. The substantial and highly statistically significant difference in mean marks between Unit 3 (where formative assessment and feedback was conducted) and Unit 2 (where no formative assessment and feedback took place) suggested that the implementation of formative assessment may have had a significant positive effect on students' learning and subsequent performance in the practical exams. This suggestion was consolidated further by the statistically significant difference in the mean marks of a different (control) group of students who studied Unit 3 during the previous academic year but were not exposed to formative assessment and feedback and the mean marks of students in this study who studied the same unit (Unit 3) but were exposed to formative assessment



and feedback. One explanation for that might be the fact that formative assessment likely provided students with opportunities for constructive feedback, self-reflection, and targeted remediation, which could have contributed to their improved understanding of anatomical concepts and enhanced proficiency in identifying anatomical structures. Our findings are in line with a recent study, which clearly demonstrated that the students who received formative assessments had significantly higher scores in both written and practical exams than those who did not receive the formative assessment.<sup>32</sup> In addition, we assume that feedback sessions in our study had positive influence on students' performance, which is supported by previous studies that report that receiving feedback from faculty after formative assessment improves their performance in future summative exams.<sup>32–34</sup> Moreover, frequent formative quizzing might have been another factor that imparted a positive impact on students' learning. This is supported by previous studies that argue that quizzes directly boosted exam outcomes and overall academic performance<sup>35–37</sup> and another study that reported that practice testing is an effective learning strategy for long-term learning.<sup>38</sup>

Our study participants showed positive perception of formative assessment and feedback conducted during human anatomy demonstration sessions, indicating their satisfaction with the benefits of formative assessment in their learning experience. Among the benefits are enhancing students' engagement, comprehension, memorization, self-evaluation, skill development, and preparation for exams in practical anatomy. The positive perception of formative assessment in this context may be attributed to its ability to provide students with timely feedback and opportunities for self-reflection, enabling them to identify and address areas of improvement in their anatomical understanding and practical skills. This finding aligns with previous research studies that have emphasized the value of formative assessment in promoting students' learning and skill development in anatomy education.<sup>15,39–45</sup> In disciplines other than anatomy, a study examining the effectiveness of formative assessment in pathophysiology education found that students responded positively to its implementation due to its effectiveness, content quality, and positive influence on learning outcomes.<sup>46</sup> Another study that explored students' views with regards to the impact of formative assessment on the outcome of summative assessment in basic biomedical sciences revealed that formative assessment had positive effect on summative assessment through minimizing students' learning gaps, encouraging students to study regularly, and motivating deep learning.<sup>47</sup>

The results showed relatively lower confidence levels among students in their knowledge of human anatomy after completing the formative assessments, suggesting that while the formative assessment and feedback sessions may have provided valuable insights into students' understanding, there may be a need to address any gaps or misconceptions that arise during these sessions and providing additional support to build students' confidence in their anatomical knowledge. This finding is consistent with previous research studies that have highlighted the importance of addressing students' misconceptions and providing targeted feedback to enhance learning outcomes in anatomy education.<sup>48–50</sup> Furthermore, this observation aligns with the phenomenon where individuals who are more competent tend to underestimate their abilities, while those who are less competent tend to overestimate their abilities,<sup>51</sup> until they receive some form of assessment and feedback that provides a more accurate perception of their actual capabilities.

No statistically significant differences in the perception of formative assessment and feedback between males and females were detected, suggesting that, overall, gender does not play a significant role in shaping students' perception of formative assessment and feedback in the context of human anatomy demonstration sessions. Only slight variations were observed in some specific items. A possible explanation for this finding is that the assessment methods and feedback mechanisms used in the sessions were objective, unbiased, equally accessible to both male and female students, leading to similar perceptions among them. This finding is consistent with the findings of Lim,<sup>12</sup> who found gender differences in only a few items, but no differences in the overall perception of formative assessment. However, this contradicts the findings of Veugen et al,<sup>21</sup> who found that males were more positive in their perceptions of their teachers' formative assessment activities than were females. Based on the contradictory findings regarding gender differences, we assume that the presence or absence of such differences may be attributed to the context of the study, the nature of the course, the used methods of formative assessment, or other factors yet to be explored.

In depth examining and understanding students' perspectives on the perceived benefits of the formative assessment and feedback sessions as well as their suggestions for improving these sessions is vital in refining and optimizing formative assessment strategies in anatomy education (Table 6).

A substantial proportion of students reported that the formative assessment and feedback sessions helped them prepare specifically for the final end-of-unit practical exam, which means that these sessions served as valuable practice opportunities, allowing them to become more familiar with the format and types of questions typically encountered in the summative assessment. This result aligns with previous research studies that have emphasized the benefits of formative assessment in enhancing exam readiness and performance.<sup>15,41</sup>

Furthermore, a notable percentage of students highlighted that the sessions aided their understanding of the subject of anatomy and facilitated the retention of easily forgettable information, suggesting that the formative assessment and feedback sessions played a role in reinforcing students' comprehension and memory of anatomical concepts. Similar results have been reported in previous research studies, where formative assessment has been associated with improved understanding and knowledge retention.<sup>40,44,49</sup> This effect of assessment is referred to as test-enhanced learning. In a systematic review, Green et al<sup>52</sup> reported that test-enhanced learning is beneficial for health professions education students as it promotes recall, retention, retrieval, and transfer of knowledge, and thus consolidation of learning. This effect is even enhanced more by immediate feedback, as indicated by Wojcikowski and Kirk.<sup>53</sup>

Regarding other perceived benefits of formative assessment and feedback sessions, some students mentioned assessing their own knowledge in human anatomy to identify the areas where they needed improvement,<sup>36,39,42</sup> reviewing what they learned in the practical sessions,<sup>41,45,54–57</sup> and reducing stress and anxiety related to the summative practical exams.<sup>58–60</sup>

In terms of suggestions for improvement, the most frequently mentioned suggestion was to upload questions with explanatory feedback on Moodle® Learning Management System (LMS) for self-review, reflecting students' desire for additional resources that would enable them to engage in self-directed learning and further consolidate their understanding of anatomical concepts. This suggestion aligns with the growing use of LMSs and online platforms in providing formative assessment materials and resources in medical education.<sup>61–64</sup>

Additionally, a considerable proportion of students suggested adding more questions to the formative exam, indicating their interest in having a larger pool of diverse assessment items (that also include embryology and histology) to practice and assess their knowledge. Providing a diverse range of questions can enhance students' exposure to different scenarios and concepts, promoting a deeper understanding of anatomy.<sup>37,65</sup>

## Limitations

This study had a few limitations. First, this study was conducted at a single institution, which could limit the generalizability of the findings. Second, a big part of the study depended on self-reported data through a survey, which could be subjected to response bias and the subjective nature of perception. However, in-depth data was obtained from the students through the open-ended questions. Third, other variables or factors than formative assessment and feedback (eg, the possible difference in the level of content difficulty between the two compared units and the preparation of the students for the final exam) could contribute to the students' performance differences between the two units.

## Conclusion

The results of this study indicate that the students had positive perceptions of formative assessment and feedback conducted during anatomy practical sessions in terms of improving understanding and memorization, identifying misunderstandings of human anatomy, getting prepared for final exams, and reducing exam-related anxiety. Moreover, the implementation of formative assessment possibly improved students' final practical anatomy exam performance, which could be further explained by the effect of test-enhanced learning. According to these results, we recommend formative assessment to be part of the assessment program in anatomy and possibly in other biomedical sciences education. Such assessment is better conducted after the educational sessions and followed immediately by constructive feedback that focuses on students' strengths and weaknesses. This could be beneficial to consolidate students' learning and improve their exam performance. However, other factors than feedback must be considered as contributing factors in improving students' exam performance. In-depth studies are needed to investigate such factors.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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