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Research Article

Perspectives And Preferences Of Medical Students Toward Multiple Analytic Questions In Histology

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ABSTRACT

A proficient questioning style can enhance learner engagement during histology lectures for undergraduate medical students. The aim of this study was to evaluate Second-year medical undergraduates' assessments of structure-based and function-based reasoning questions during histology lectures. This cross-sectional analytical study involved 150 students, with reasoning questions developed for seven general histology classes. Students encountered two or three structure-based and function-based reasoning problems during the lecture, allotted approximately two minutes for discussion before the teacher's elaboration, and the questions were reviewed at the conclusion of the sessions to reinforce the fundamental concepts. Students filled out an anonymous perception questionnaire with 10 items and two open-ended questions regarding the advantages and disadvantages of the intervention. The Wilcoxon signed-rank test and the Mann-Whitney U test were employed to assess group differences. The results demonstrated that student perceptions about both structure and function-based reasoning questions were favourable, with perceptions of three items significantly elevated for the function-based reasoning questions. Marked gender disparities in views regarding both categories of questions were seen for three issues. The advantages of question-based lectures encompassed enhanced comprehension and heightened engagement, whereas insufficient topic covered during lectures was viewed as a disadvantage. The inclusion of both structure-based and function-based reasoning problems in histology lessons enhanced learner engagement, and subsequent research might examine the impact of the stated reasoning strategy on learning outcomes.

Keywords: Histology; Medical students, clinical reasoning, cognitive behavior, Perception

Introduction:

The appropriate understanding of the normal physiological and pathological processes of diseases is based on histology. Lectures continue to serve as the foundation for histology instruction at our institution, and educators frequently encounter challenges in encouraging student engagement during lectures. Learners frequently endeavour to memorize the structural organization of tissues, including the staining characteristics, the pattern of structure arrangement, and the shape and position of nuclei. However, they neglect to investigate the underlying rationale behind these characteristics (Higazi, 2011). Behavioural engagement with the learner is achieved through the real-time illustration of microscopic slides and the creation of diagrams in pedagogical approaches such as live digital imaging and draw-along techniques. Nevertheless, the learner's comprehension of the rationale behind the arrangement of the structural components is not considered by these teaching methods (Balemans et al., 2016). The real-world applications of histology are rarely addressed in lectures, even though medical educators frequently correlate histological features with physiological concepts to improve the correlation of its functions. Therefore, it is essential to develop an instructional strategy for histology lectures that integrates these components (McBride et al., 2008).
Student engagement includes several activities that foster learning and professional development in students. It is seen as multidimensional, encompassing emotional, behavioural, and cognitive dimensions (Kotze and Mole, 2015). Motivation, intellectual integration, and emotional connection are intricately associated with student involvement. Prior histological research has identified active draw-along techniques and concept mapping as efficacious engagement tools (Balemans et al., 2016). Comprehending what engages millennial

learners in lectures is essential, as student involvement promotes higher-order thinking and enhances learning outcomes (Payne, 2017).
Questions facilitate learning by activating pertinent cognitive processes, rendering them essential in lectures. They may be categorized in multiple manners, including convergent or divergent. Convergent questions are closed-ended, offering restricted possibilities or a singular proper response, whereas divergent questions are open-ended, necessitating higher-order thinking and the formulation of replies that may encompass numerous perspectives (Sachdeva, 1916). Bloom's taxonomy of cognitive levels and knowledge dimensions can be utilized to categorize queries. Question circles provide a conceptual framework for the formulation and application of questions in the classroom, emphasizing factual substance, personal experiences, and contextual relevance. Initially, inquiries should pertain to a singular circle, progressively escalating in complexity to encompass two circles, and ultimately incorporating all three dimensions (Tofade et al., 2013). A successful questioning method fosters critical thinking, enhances learner engagement, encourages introspection, and facilitates the construction of new information. Nevertheless, even seasoned instructors frequently depend on recall-based inquiries that fail to provoke profound contemplation. Conversely, posing too challenging questions to inexperienced learners might erode their confidence and result in disengagement (Kost and Chen, 2015).

Although prior research highlights the efficacy of questioning approaches in enhancing cognitive processes, there is a lack of empirical data connecting the nature of the questions posed to learner involvement. This study presented two categories of reasoning questions—structure-based (concentrating on the reasons for structural configurations) and function-based (highlighting functional significance in practical contexts)—during general histology courses to improve learner engagement. This technique corresponds with the educational paradigm that promotes a more interactive methodology focused on knowledge synthesis. Considering that students' perceptions of the learning environment significantly influence learning results, comprehending the impact of question design on fostering student engagement may be advantageous for instructors (Black and Smith, 2004). This study aimed to evaluate and compare first-year medical undergraduates' assessments of structure-based and function-based reasoning questions during histology lectures.

Materials and Methods:

This cross-sectional analytical study encompassed the complete cohort of One hundred eighty-nine (189) MD2 year medical undergraduate students of College of Medicine and Health sciences, National University Oman. Reasoning questions were incorporated into histology lectures, selected based on the students' past knowledge from their MD1 year for enhanced conceptual comprehension. Seven general histology courses, delivered weekly by the same instructor, encompassed subjects like epithelial glands, connective tissue, cartilage, bone, muscle, blood vessels, and skin. The lead author developed reasoning questions and clues for each session, which were evaluated by two senior faculty members for consistency with session objectives, delivery method, enhancement of structural or functional thinking, and suitability of clues. Following the articulation of the lecture objectives, students were provided with two or three reasoning questions, guaranteeing the inclusion of at least one structure-based and one function-based question per lecture.
Examples of structure-based reasoning questions presented during the lectures include the following: 1) Which histological feature distinguishes exocrine glands from endocrine glands in terms of secretion pathways?; 2) What structural component of connective tissue provides tensile strength and resists stretching?; 3) How does the arrangement of chondrocytes in hyaline cartilage contribute to its function and appearance?; 4) What is the significance of the concentric lamellae arrangement in compact bone histology?; 5) How do the structural differences between skeletal and cardiac muscle fibres relate to their respective functions?; 6) What histological characteristic differentiates elastic arteries from muscular arteries? These inquiries were formulated to investigate the reasoning underlying the structural organization of tissues.
Several instances of function-based reasoning inquiries addressed were as follows: 1) How does the structure of exocrine glands facilitate the secretion of their products?; 2) How do fibroblasts in connective tissue contribute to tissue repair?; 3) How does the lack of blood vessels in cartilage affect its ability to heal after injury?; 4) How do osteoclasts contribute to bone remodelling and calcium homeostasis?; 5) How does the organization of actin and myosin in skeletal muscle enable contraction?; 6) How does the structure of capillaries facilitate the exchange of gases and nutrients?. All function-based reasoning inquiries examined the functional relationships of recognizable real-world situations.
Students were allocated around two minutes to engage in discussion on each issue with their colleagues utilizing the "pair and share" method. The students' responses were subsequently analysed and pondered. When students encountered difficulties in locating answers, the lecturer offered hints to assist them instead than supplying the answers outright. At the conclusion of each lecture, the reasoning questions were revisited to reinforce the fundamental concepts.
The students were instructed to complete an anonymous perception questionnaire with 10 positively framed items, which were to be assessed on a five-point Likert scale. A superior score signified a more favourable reception. The items pertained to students' interests, comprehension levels, preferences for fact-based inquiries, time allocated for discussions, motivation to engage in discussions, stimuli to elicit logical responses, utility of clues during the questioning session, capacity to answer questions accurately post-lecture, perceived

enhancement in academic performance, and endorsement of analogous teaching methodologies in the future. The students' perception questionnaire was evaluated for internal consistency across a cohort of 15 students (Cronbach's alpha = 0.830). The questionnaire included two open-ended questions regarding the advantages and disadvantages of the intervention. The questionnaire was distributed to the student's post-tests for ethical reasons. The disparity in student perception scores between structure-based and function-based reasoning questions was assessed using the Wilcoxon signed-rank test. The Mann-Whitney U test was employed to assess gender disparities in perception scores. The statistical analysis was conducted utilizing SPSS version 17.0, with a p-value of less than 0.05 being statistically significant.

Results

A total of 126 students (12 males and 114 females) completed the perception questionnaire. Table 1 presents the student perception scores for questions related to structure and function-based reasoning. For both question types, seventy percent of items earned a mean score exceeding four, signifying a favourable perception. Nonetheless, the duration allocated for discussions, the efficacy of the hints, and the capacity to respond to inquiries by the conclusion of the class were assessed as inferior for both categories. Function-based reasoning questions markedly surpassed structure-based questions in stimulating interest, facilitating comprehension, and receiving endorsements for future courses.

Male students assessed their perceived comprehension of both structure-based and function-based reasoning tasks considerably higher than female students. By the conclusion of the lesson, they demonstrated increased confidence in addressing function-based inquiries. In contrast, female students deemed the clues offered by the teacher considerably more beneficial for both question types than their male counterparts. Furthermore, female students expressed greater satisfaction with the duration allocated for conversations regarding structure-based inquiries (Tables 2 and 3).

Certain responses to the open-ended questions were excessively ambiguous to be incorporated into the thematic analysis. The question-based lectures offered multiple advantages: they augmented comprehension of tissue morphology, facilitated a more engaging educational experience relative to conventional lectures, and fostered a greater awareness of histological features during laboratory sessions. Nonetheless, a significant downside was the perceived inadequate treatment of the topic in lectures owing to the time allocated to discussing reasoning issues.

Table 1. Students' views on questioning techniques focused on structure and function during histology lectures

S. No.	Statement in questionnaire	Structural reasoning Mean ± SD	Functional reasoning Mean ± SD	P-value (Wilcoxon signed rank test)
1	The lectures' reasoning-based questions were intriguing	4.13 ± 0.51	4.35 ± 0.47	<0.001*
2	The lecturer's questions gave me his meaning	4.12 ± 0.74	4.21 ± 0.77	0.891
3	Reasoning questions helped students understand histology better than fact-based lectures	4.04 ± 0.69	4.19 ± 0.68	0.033*
4	Discussion time for logic questions was sufficient	3.79 ± 0.72	3.71 ± 0.83	0.136
5	Reasoning questions got me involved in lecture discussions	4.25 ± 0.72	4.34 ± 0.72	0.074
6	The reasoning questions made me think logically.	4.11 ± 0.73	4.12 ± 0.83	0.781
7	Tips from the questioning session were helpful	3.86 ± 0.83	3.83 ± 0.85	0.471
8	After the lecture, I could answer reasoning problems correctly	3.77 ± 0.81	3.86 ± 0.80	0.302
9	Reasoning problems improved my histology grades	4.23 ± 0.73	4.20 ± 0.83	0.333
10	I want similar teaching methods in future classes	4.36 ± 0.66	4.50 ± 0.61	<0.001*

Table 2. Variations in Students' Perceptions of Structure-Based Questioning in Histology Lectures by Gender

S. No.	Statement in questionnaire	Structural reasoning Mean ± SD	Functional reasoning Mean ± SD	P-value (Wilcoxon signed rank test)
1	The lectures' reasoning-based questions were intriguing	4.18 ± 0.69	4.09 ± 0.74	0.453
2	The lecturer's questions gave me his meaning	4.31 ± 0.52	3.95 ± 0.69	0.001*
3	Reasoning questions helped students understand histology better than fact-based lectures	4.08 ± 0.79	4.01 ± 0.78	0.578
4	Discussion time for logic questions was sufficient	3.56 ± 0.68	3.92 ± 0.68	0.004*
5	Reasoning questions got me involved in lecture discussions	4.37 ± 0.67	4.12 ± 0.77	0.073
6	The reasoning questions made me think logically.	4.07 ± 0.81	4.17 ± 0.71	0.617
7	Tips from the questioning session were helpful	3.57 ± 0.90	4.10 ± 0.69	0.001*
8	After the lecture, I could answer reasoning problems correctly	3.78 ± 0.84	3.76 ± 0.79	0.807
9	Reasoning problems improved my histology grades	4.22 ± 0.73	4.25 ± 0.75	0.638
10	I want similar teaching methods in future classes	4.30 ± 0.57	4.37 ± 0.71	0.363

Table 3. Variations in Students' Perceptions of Function-Based Questioning in Histology Lectures by Gender

S. No.	Statement in questionnaire	Structural reasoning Mean ± SD	Functional reasoning Mean ± SD	P-value (Wilcoxon signed rank test)
1	The lectures' reasoning-based questions were intriguing	4.47 ± 0.62	4.42 ± 0.71	0.919
2	The lecturer's questions gave me his meaning	4.34 ± 0.55	3.93 ± 0.69	0.001*
3	Reasoning questions helped students understand histology better than fact-based lectures	4.30 ± 0.69	4.11 ± 0.82	0.249
4	Discussion time for logic questions was sufficient	3.53 ± 0.84	3.81 ± 0.77	0.092
5	Reasoning questions got me involved in lecture discussions	4.37 ± 0.68	4.31 ± 0.71	0.669
6	The reasoning questions made me think logically.	4.05 ± 0.94	4.21 ± 0.79	0.402
7	Tips from the questioning session were helpful	3.62 ± 0.85	3.98 ± 0.85	0.016*
8	After the lecture, I could answer reasoning problems correctly	4.07 ± 0.78	3.72 ± 0.79	0.012*
9	Reasoning problems improved my histology grades	4.10 ± 0.77	4.23 ± 0.83	0.249
10	I want similar teaching methods in future classes	4.55 ± 0.53	4.43 ± 0.63	0.414

Discussion

This study sought to improve student engagement in histology lectures by including reasoning problems cantered on structure and function into the instructional framework. This method aimed to resolve the problem of student's rote remembering histology slide characteristics without understanding their structural or functional importance. Student perceptions were assessed by a questionnaire comprising both qualitative and quantitative components. Students exhibited a favourable response to the structure and function-based reasoning inquiries. Significant disparities arose in their judgments of structure-based versus function-based questions across multiple parameters, accompanied by pronounced gender inequalities in responses to both question types.

Despite the extensively demonstrated advantages of inquiry in promoting learning, it frequently receives insufficient time during instructional sessions. This study deliberately incorporated questions into the instructional design of histology lectures, dedicating substantial time to enhance student participation (Sachdeva, 1996). A prevalent problem is the over reliance on questions necessitating mere factual recollection, probably stemming from a perceived insignificance of higher-order inquiries and the challenges associated

with formulating them (Cho et al., 2012). This study addressed these issues by meticulously creating and verifying questions prior to their implementation in lectures. Deep inquiry in a collaborative environment, accompanied by reflection, is posited to augment learning. This study's interrogation technique encompassed these components.

Prior research has investigated the effect of incorporating multiple-choice questions into lectures on educational outcomes (Campbell and Meyer, 2009). A study involving occupational therapy students revealed that the inclusion of multiple-choice questions in online lectures enhanced examination scores related to the transfer of learning. This enhancement was ascribed to the testing effect, wherein students exhibited superior performance when assessed on the material rather than simply being exposed to it (Griswold et al., 2017). Comparable results were noted among psychology students, who demonstrated enhanced recall and transfer test performance when multiple-choice questions were incorporated into lectures, as opposed to when the material was delivered as assertions. An intervention utilizing audience response systems exhibited markedly superior short- and long-term information acquisition in students who encountered questions during lectures, in contrast to those who did not. These students additionally indicated elevated levels of involvement and enjoyment (Mains et al., 2015). A further study indicated that the inclusion of questions, as opposed to the utilization of audience response systems, resulted in enhanced learning outcomes (Anthis, 2011). A study employing a variable number of multiple-choice questions, encompassing both low and high cognitive levels during lectures, revealed that increasing the number of questions did not inherently enhance learning outcomes, despite students expressing favourable impressions regarding the incorporation of questions in lectures (Hessheimer, 2011).

A study involving health science students in an undergraduate human anatomy and physiology course implemented a collaborative assessment method, promoting peer discussion on their comprehension. This strategy was contrasted with a short-answer quiz in which students did not justify their responses or participate in peer conversations. Learning outcomes were subsequently assessed by scores obtained from multiple-choice tests. Results indicated markedly superior scores on examination questions pertaining to collaborative quiz subjects in contrast to those associated with short-answer quiz topics. This enhancement was ascribed to the expression of scientific thinking in group debates, which promoted metacognitive processes (Krontiris, 2009). In the current study, students were required to not only respond to the questions but also engage in discussions with their peers. Furthermore, the instructor employed these questions to facilitate learning throughout the lesson.

The present study demonstrated that both structure- and function-based reasoning problems significantly enhanced student engagement in histology lectures. Classroom learning is the selection, organization, and integration of material. Students must select pertinent information throughout a session, structure it, and assimilate it with their pre-existing knowledge. Effective inquiry promotes these processes, promoting learning. Foreseeing a question enhances student engagement, hence augmenting information selection. The inquiry necessitates that students synthesize material and incorporate it with previous knowledge to formulate a response. Feedback following responses initiates self-evaluation, aiding in the identification of learning deficiencies. The elevated evaluation of function-based questions may result from the prompt emotional reaction to pertinent real-world situations (Campbell and Meyer, 2009). Prior research has identified gender disparities in verbal and visuospatial working memory skills, as well as in language processing among children. Pronounced gender disparities in questionnaire scores may indicate several issues. Responses to open-ended questions correspond with questionnaire scores, and certain students' apprehensions regarding insufficient topic coverage due to time limitations underscore their expectations for content presentation in lectures (Zilles et al., 2016).

This research possesses specific limitations. The learning consequences of the questioning tactics were not evaluated. The present study design was limited by various confounding variables that may have affected the outcomes. Logistical constraints precluded the use of a randomized controlled research design, which would have been optimal. Notwithstanding these constraints, the study is expected to improve comprehension of how advanced questions might promote student participation during lectures. Medical educators may utilize real-world scenarios, as demonstrated in this study, when clinical scenarios that align with the course content are limited. The metacognitive skills of students subjected to these pedagogical methods are expected to enhance, facilitating profound learning and improved transfer of knowledge. Subsequent research may examine alterations in learning outcomes linked to the reasoning methodology outlined in this study.

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