Research Square

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Drawing serves as a useful instrument for understanding Pathology for medical students: Experience of the Faculty of Medicine of Agadir

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Abstract

Background:

The development of visual reasoning and diagnostic interpretation skills is essential in the teaching of anatomical pathology. However, traditional teaching methods often rely on passive observation, which may limit student engagement and hinder knowledge retention. Integrating active learning tools, such as drawing, could promote a better understanding of morphological concepts.

Methods:

This mixed-methods study was conducted with 194 third-year medical students randomly assigned into two groups. Group A (n = 93) studied three pathological entities (appendicitis, tuberculous granulomas, and well-differentiated colonic adenocarcinoma) by creating simplified schematic drawings in addition to observing microphotographs. Group B (n = 101) learned the same entities through direct observation of microscope slides only. After a two-hour practical session, students were assessed with a 14-point test based on the identification of histological elements on virtual slides. The results were analyzed using Jamovi software (v.2.5.3).

Results:

The average score in Group A (12.58 ± 1.14) was significantly higher than that of Group B (11.36 ± 1.75) ($p < 0.001$), indicating a positive impact of drawing on student performance.

Conclusions:

Using drawing as a learning strategy in pathology significantly improves short-term knowledge retention and student performance. Drawing represents an effective and engaging active learning approach, facilitating the integration of foundational knowledge within a clinical context.

Introduction

In medicine, numerous disciplines depend on the interpretation of visual signs and the reliance on visual memory. The significance of visual memory and the ability to interpret visual indicators are especially vital in pathological anatomy [1]. Such skills are indicative of a potential to cultivate visual intelligence [2].

Evaluations have revealed that students often struggle to fully and systematically grasp anatomical pathology. Additionally, there has been a noted decline in the retention of basic science knowledge and

its application in clinical practice. Understanding anatomical pathology remains crucial for safe clinical practice [1].

This shortfall in understanding basic pathology would certainly negatively impact pathology residency programs, where most trainees display poor foundational knowledge. Consequently, they struggle to recognize pathological changes in tissue preparations [3, 4].

For more than ten years, the gradual inclusion of drawing in medical education has brought numerous benefits, such as enhanced empathy and a greater tolerance for ambiguity [5–14].

Additionally, the use of visual arts in medical studies has notably improved observational skills [6]. Despite the crucial role these skills play in medical education overall, and particularly in the education of pathological anatomy, there are no established guidelines to effectively equip medical students with resources to develop their visual intelligence [15].

Materials and Methods

At the Faculty of Medicine and Pharmacy of Agadir, practical sessions are conducted to reinforce students' understanding of specific pathological entities. During the 2023–2024 academic year, the selected pathologies for in-depth study included acute appendicitis, tuberculosis, and well-differentiated colonic adenocarcinoma. These practical sessions were structured in two phases: a theoretical phase, where key diagnostic features were introduced using microphotographs and explanatory diagrams, followed by a practical phase, where students examined complete virtual slides mimicking real histological samples.

This study follows a mixed-methods design, investigating the impact of drawing-based learning versus traditional observation-based learning on knowledge retention in pathology. A total of 194 third-year medical students were recruited and randomly assigned into two groups. Group A, consisting of 93 students, learned the selected pathological entities through drawing diagrams and observing microscopic images. Group B, consisting of 101 students, engaged with microscopic images only, without the support of diagrams.

The diagrams provided to Group A were simplistic, limited in color to mimic hematoxylin and eosin (H&E) staining, and accompanied by detailed legends describing key morphological features. After a brief explanation of each component, students replicated these diagrams as they followed the theoretical session, using colored pencils or regular pencils. Conversely, Group B did not have access to diagrams and relied solely on microscopic observation.

During the practical phase, students in both groups were required to identify key histological structures on virtual slides. The assessment was based on a checklist containing specific elements that students needed to recognize on the virtual slide. If a student correctly identified an element, they received one point; otherwise, they received zero points. The total score was calculated as the sum of all correctly

identified elements. The evaluation covered different pathological features depending on the slide, including normal appendix mucosa, ulceration, fibrinoleukocytic exudate, altered crypts, neutrophils, granulomas, giant cells, epithelioid cells, necrosis, lymphocytes, dysplastic crypts, carcinomatous invasive glands, serosal infiltration, and lymphocytes in the tumor microenvironment. The maximum possible score for each student was determined by the total number of elements included in the evaluation grid (Appendix 1).

Statistical Analysis

Data analysis was performed using Jamovi (version 2.5.3). The test scores were analyzed using the independent samples t-test to compare the performance between Group A and Group B. Additionally, a paired samples t-test was used to evaluate intra-group differences across different learning strategies.

Results

General Descriptive Statistics of Scores: (Table 1**)**

The study included a total of 194 students, with 93 students in Group A and 101 students in Group B.

- Group A (Diagrams + Observation) achieved an average score of 12.92 (± 1.13).
- Group B (Observation Only) obtained an average score of 11.61 (± 1.79).

Table 1
Descriptive Statistics of Student Scores in Each Group

Group	Number of students	Mean Score	Standard Deviation	Minimum Score	Maximum Score	Median
Group A (Diagrams + Observation)	93	12.92	1.13	10	14	13
Group B (Observation Only)	101	11.61	1.79	6	14	12

The results show that Group A, which used diagrams in addition to microscopic observation, outperformed Group B, which relied solely on microscopic observation.

Statistical Comparison Between Groups:

An independent samples t-test was conducted to evaluate the statistical significance of the observed difference.

- t-statistic = 6.13
- p-value = 5.89×10^{-9}

Since $p < 0.001$, the difference in scores between the two groups is highly significant, indicating that students who learned through diagrams and microscopic observation (Group A) performed significantly better than those who relied on microscopic observation alone (Group B).

Analysis of Scores by Gender : (Tables 2 and 3**)**

To identify potential variations, the results were analyzed based on gender.

Table 2 : Score Statistics by Gender – Group A (Diagrams + Observation):

Gender	Count	Mean	Std	Min	Max
Female	55	12,89	1,08	10	14
Male	38	12,97	1,22	10	14
Std : Standard deviation ; Min : Lowest score ; Max: Highest score					

Table 3
Score Statistics by Gender – Group B (Observation Only):

Gender	Count	Mean	Std	Min	Max
Female	66	11,65	1,71	7	14
Male	35	11,54	1,98	6	14
Std : Standard deviation ; Min : Lowest score ; Max: Highest score					

The results indicate no major gender-related differences, suggesting that learning method effectiveness was independent of gender.

Analysis of Scores by Age : (Tables 4 and 5**)**

Students were categorized into three age groups to examine the potential influence of age on performance.

Table 4
Scores by Age Group – Group A (Diagrams + Observation):

Age group	Number of Students	Mean score	Standard Deviation	Minimum Score	Maximum Score
18–20	81	12,89	1,15	10	14
21–22	12	13,17	1,03	11	14
23–25	0	-	-		

Table 5
Scores by Age Group – Group B (Observation Only):

Age group	Number of Students	Mean score	Standard Deviation	Minimum Score	Maximum Score
18–20	67	11,733	1,54	8	14
21–22	32	11,4	2,23	6	14
23–25	2	11	2,83	9	13

There is no clear trend based on age, although younger students (18–20 years) tended to show slightly more score variation.

Interpretation of Results:

The results suggest that using diagrams in addition to microscopic observation (Group A) significantly improved immediate performance compared to microscopic observation alone (Group B). Group A students performed significantly better, indicating that incorporating drawing helped reinforce essential diagnostic elements and improved retention.

This study focuses solely on immediate knowledge retention, but further investigations are necessary to determine whether the use of diagrams contributes to better long-term memory retention and deeper understanding of histological structures.

Future Perspectives :

In order to gain a deeper understanding of the long-term impact of drawing on learning, a follow-up test conducted several weeks after the initial session could help evaluate whether this method enhances knowledge retention over time. Such an approach would provide valuable insights into the durability of learning outcomes associated with drawing.

Additionally, a qualitative analysis through a targeted survey could shed light on students' perceptions of each learning method. This would allow for a better understanding of whether drawing contributes to improved conceptualization of pathological structures and how learners subjectively evaluate its usefulness compared to other strategies.

Finally, broadening the study to include other types of lesions would help determine whether the benefits of drawing are influenced by the complexity or nature of the pathological structures. Such an exploration could identify which contexts are most conducive to learning through visual representation and help adapt teaching strategies accordingly.

Discussion

Histology and anatomical pathology have long been undervalued within the medical curriculum. Students are typically assessed on their ability to recognize tissue types rather than understand their clinical relevance, leading to a progressive erosion of foundational knowledge as they transition into clinical years [16]. To address this, our study explored the integration of drawing as a pedagogical tool in general pathology education, aiming to enhance knowledge retention and engagement.

Our findings revealed that students who learned through drawing diagrams in addition to observing microscopic images (Group A) achieved significantly higher average scores than those who relied solely on microscopic observation (Group B). This result aligns with the growing body of evidence supporting the cognitive benefits of drawing in medical education. In our assessment of 14 points, Group A achieved a mean score of 12.58 (SD = 1.14), while Group B averaged 11.36 (SD = 1.75), a statistically significant difference ($p < 0.001$).

Several mechanisms may account for this advantage. Drawing has been shown to reinforce memory by engaging visual, kinesthetic, and semantic systems [17]. It encourages students to distill complex information, make inferences, and actively construct mental models, which enhances comprehension and performance in higher-order assessment tasks [18]. Furthermore, self-monitoring during drawing helps learners identify and correct misunderstandings, thereby facilitating deeper learning [19].

Our findings are in agreement with those of Rafi et al. [17], who demonstrated that students performed significantly better on post-tests when learning histology through drawing than through observation alone. While their crossover design did not reveal significant differences between groups at a given time point, intra-individual comparisons showed consistent improvements in performance when drawing was incorporated. This echoes our own approach, where students were assessed immediately after exposure to drawing-based or observation-only sessions.

Beyond test scores, the qualitative value of drawing is also evident in students' attitudes. In our prior perception-based study [20], a majority of students reported that drawing facilitated their understanding of complex pathological structures and enhanced their willingness to integrate it into their study routines. Notably, after participating in the drawing-integrated session, the proportion of students in Group A who expressed an intention to use drawing in the future increased significantly ($p < 0.01$).

This is consistent with the findings of Cracolici et al. [21], where 47.5% of students indicated they would continue using drawing to study medicine, and those exposed to drawing reported more favorable experiences than those taught without it (75% vs. 40.6%; $p = 0.10$). Such perceptions underline the motivational value of drawing, which, in turn, may foster better engagement and learning outcomes.

While drawing offers clear advantages, it is not without limitations. Students in our sessions, as well as in the studies of Rafi et al. and others [22, 23], identified time consumption and a lack of confidence in their drawing skills as barriers. This underscores the need to focus on the precision and relevance of drawings rather than artistic quality. Supporting students with structured, simplified diagrams—as we did —can mitigate these concerns and promote participation even among those less artistically inclined.

It is also important to consider individual learning preferences. Some students may benefit more from text-based or interactive visual methods than from drawing per se. Therefore, while promoting drawing, it should not be imposed as the sole learning strategy, but rather offered as a complementary tool.

Another valuable insight from our study is the need to shift from passive observation to active engagement in histology and pathology education. As digital microscopy becomes increasingly prevalent, there is a risk of replacing meaningful interaction with mere visual exposure. Drawing reintroduces a tactile and interpretive dimension that anchors abstract structures in the learner's mind. This resonates with recommendations from prior literature to adopt active strategies like "Observe-Reflect-Draw-Edit-Repeat" in anatomy and histology education [24, 25].

Conclusion

In conclusion, drawing enhances both knowledge retention and student engagement in general pathology teaching. Our results, combined with those of previous studies, support the integration of drawing into the medical curriculum, particularly for visually intensive disciplines like histology and anatomical pathology. Future research should assess the long-term retention benefits and explore how to tailor drawing-based methods to diverse learner profiles.

Declarations

Data and software availability:

Underlying data :

Repository: Dataset from the study *"Drawing serves as a useful instrument for understanding Pathology for medical students: Experience of the Faculty of Medicine of Agadir"*.
https://doi.org/10.5281/zenodo.15106142

This project contains the following underlying data:

• evaluation_grid.pdf (Evaluation grid used to guide the drawing-based pathology activity)

• group_A_scores.xlsx (Raw individual scores from Group A students)

• group_B_scores.xlsx (Raw individual scores from Group B students)

Data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 1.0 Public domain dedication).

Ethics approval and consent to participate:

- The study was submitted to and approved by the Ethics Committee of the Faculty of Medicine and Pharmacy of Agadir (Comité d'éthique de la Faculté de Médecine et de Pharmacie d'Agadir). All

procedures involving human participants and data were conducted in accordance with the ethical standards of the institutional research committee and with the principles of the Declaration of Helsinki (2013), as revised and published by the World Medical Association

- Informed consent to participate was obtained from all participants prior to their inclusion in the study.

Consent for publication: Not applicable.

Availability of data and materials: The datasets supporting the conclusions of this article are available in the Zenodo repository (https://doi.org/10.5281/zenodo.15106142).

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Authors' contributions:

AM conceptualized the study, conducted the analysis, and drafted the manuscript. MT contributed to the study design and critical revision of the manuscript. IC contributed to the statistical analysis. SA assisted in data collection and preparation of the manuscript. All authors read and approved the final manuscript.

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Appendix 1

Appendix 1 is not available with this version.