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## Hide and seek in pathology - A research on game-based histopathology learning

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### ABSTRACT

To know the effectiveness of a Game-Based Histopathology learning method. To create a new Image oriented Game Based Histopathology slide reading method. To know the usefulness of the new method. To compare the conventional learning and game-based learning methods. Two groups of undergraduate students were tested with two different learning methods to identify pathology slide sections of four lesions. For each group, sixteen Undergraduate dental students were selected randomly. A game was created by using histopathology images of those four lesions, and circulated among the group one. The conventional method of slide reading was given to the group two. Both the group was tested for diagnosing the four pathology lesions through light microscopy spotter identification. Results were calculated accordingly. A questionnaire survey was done based on the pattern and pathology features oriented diagnostic capacity. Results of the questionnaire survey were also analyzed. Statistically, the results of both the two groups were analyzed. An Independent t-test was done and found out there was no significant difference between the two learning methods. The questionnaire survey revealed that the group learned through game-based pathology slide learning method learned the morphological features better than that of the conventional slide learning method. The image oriented game based pathology slide learning helps the undergraduate students to diagnose the pathology lesions with proper knowledge of morphological features than the conventional slide learning method, which is mainly pattern oriented. Though it is a very complicated procedure, the game based slide learning method is fun, creative and involves a majority of the student's attention towards morphological features of any pathological lesions.

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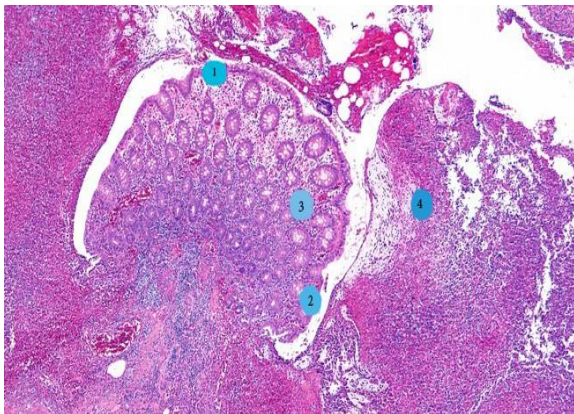
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### INTRODUCTION

Pathology is a vast science and it requires the student to grasp the concepts well, so as to identify the pathological stature of a given specimen. Morphological identification plays a vital part in understanding pathology and comprehending the pathogenesis of a particular lesion or structure (Buckley BC 2000). The histological study of diseased tissues and their morphological identification is vital for teaching pathology and essential for inculcating a working knowledge of mechanisms of any particular disease (Kanthan R, Senger JL 2011). For many students, having a visual representation helps solidify concepts of disease and injury and adds a real-life element that cannot be

achieved by the written word alone (Dee FR 2009). This is where image-based learning plays a vital role in helping the students have a strong foundation in their basics, thus paving a path for them to correlate what they learn to what they will see (Regezi JA, 2016).

In addition to contributing to a student's understanding of basic concepts and principles, studying microscopic slides requires the viewer to discover or extract information on his or her own. In this way, the use of microscopic slides encourages the medical student to develop a systematic method of approaching an unknown situation. As medical students will be future clinicians, analysis of slides and images regarding the morphology and histology of a pathological condition will help in making them proficient in analyzing a patient and carry out a thorough and well analyzed physical examination of a said patient (Koles PG, et al., 2010).



**Figure 1: Acute Appendicitis HPE picture with hidden features**

Although images are often used in the classroom to communicate difficult concepts, students have little input into their selection and application. This approach can create a passive experience for students and represents a missed opportunity for instructors to engage participation. By applying concepts found in pathology to techniques identified for the imaging in teaching and learning, an image-based learning model can be created and used in classroom teaching. This combination will increase the student comprehension, challenged and altered perceptions of key topics, and gave them a greater sense of agency through reflexive learning. (Whitley and Cameron. 2013).

Digitalisation, from the earliest era with computer laboratories to the latest digitalization with ipads and android systems in the learning and teaching, is common in medical schools, and institutions all over the world. One of the innovations (Innovations 2014) that the undergraduates are exposed to the real-time experience of a histopathology slide and not mere a fixed field. Also, the students capture a relevant diagnostic field from

the H and E Slide and trace the appropriate field. In this manner, each student gets exposed to a different field and traces the picture using the Brushes app in iPad. This helps the student to better understand the morphology of the tissue reinforcing the histopathological features of a particular pathology.

Digital images are routinely used for the research purpose in pathology, but most diagnostic pathologists are unfamiliar with the technology and its possibilities. The review by Furness PN (Furness PN 1997) explained the basic principles of digital image acquisition, storage, manipulation and use, and the possibilities in teaching and in routine diagnostic pathology. Images of natural objects are usually expressed digitally as 'bitmaps'--rectilinear arrays of small dots. The size of each dot can vary, but so can its information content in terms, for example, of color, greyscale or opacity. The various file formats and compression algorithms are available in different software systems. Digital cameras and scanners are alternative acquisition tools of relevance to pathologists. Once acquired, a digital image can easily be subjected to conventional darkroom manipulation and modern software allows much more flexibility. The combination of digital images and the Internet raises many possibilities; for example, instead of seeking one expert diagnostic opinion, one could simultaneously seek the opinion of many, all around the globe.

Digital-based teaching and learning methods offer self-paced learning and the ability to revisit material as often as necessary for clarification, is especially appropriate to pathology because the interpretation of Pathology is highly subjective and based on visual perception. Learning about concepts in general pathology and about clinicopathological correlation can be facilitated by using illustrative macroscopic specimens and microscopic pathology images in interactive digital-based learning modules (Kumar RK, et al., 2004).

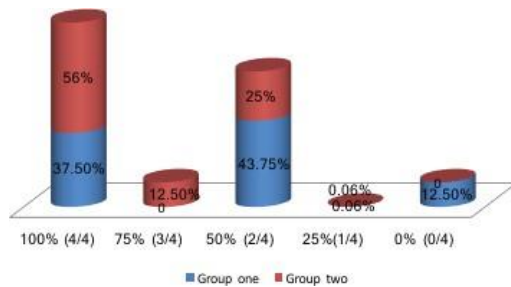
Automated whole slide imaging (WSI) systems are becoming robust for pathological diagnosis and classroom discussions. Modern devices can scan a slide section in 5 minutes and retrieve the images for histopathology analysis (Gilbertson JR, 2006). In addition, students can assess their knowledge and understanding through computerized formative assessments, which can provide automated feedback. At the higher version of the whole slide imaging systems is a virtual 3D microscopic method of histopathology imaging. Virtual 3D microscopy is the best alternative for the conventional microscopy in histopathology diagnosis (Kalinski T, et al., 2008). As the techno era grows up

the pathology imaging technology also grows enormously. This study was done to find out the use of the basic histopathology images as an active game-based learning in the undergraduate pathology practicals.

**MATERIALS AND METHODS**

This study compared two learning methodology.

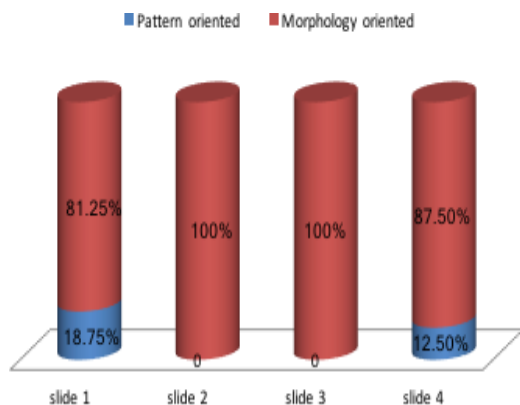
1. Image oriented Game based slide reading method
2. Conventional slide reading method



**Figure 2: Light microscopy test results of both Group one and Group two**

**Image oriented Game based slide reading method**

High-resolution Hematoxylin and eosin stained histopathology images of histopathology lesions for undergraduate level were selected. The salient diagnostic features were hidden by using Photoshop software. Hints for those hidden features were given as a short prose. The participants have to find out the hidden features by using the hint in the prose and at last, they have to diagnose the lesion.

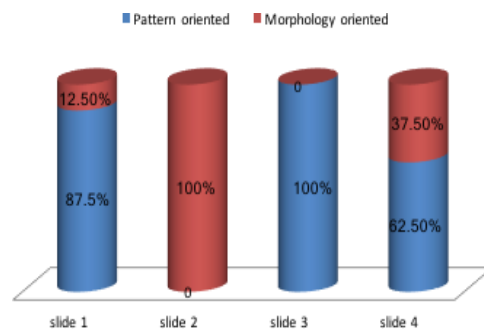


**Figure 3: Basis of Diagnosis among Group one**  
**Conventional slide reading method**

Histopathology slides were focused statically at a single focus. The participants were given the diagnosis and instructed to see the focus with the identification points written on the board or separate charts.

**Study design**

Two groups of undergraduate dental students were tested with two different learning methods to identify pathology slide sections of four lesions (Acute appendicitis, Granulation tissue, Tuberculous lymphadenitis and Fatty liver). For each group, sixteen Undergraduate dental students were selected randomly. Image oriented Game based slide reading method was circulated among the group one. The conventional method of slide reading was given to the group two. Both the group was tested for diagnosing the four pathology lesions through light microscopy. Results were calculated accordingly.



**Figure 4: Basis of Diagnosis among Group two**

A questionnaire survey was done based on the pattern and pathology features oriented diagnostic capacity among all the study population. Results of the questionnaire survey also analyzed.

**DISCUSSION**

The light microscopic test results are shown in Figure 1. For the Group one who followed Image Oriented Game-Based Learning showed 37.5% of the study population obtained 100% marks, followed by 0%, and 43.75%, 0.06%, and 12.5% diagnosed three, two, one and zero lesion out of four lesions which were given for the test. For the Group two who followed the Conventional Learning Method, showed 56% of study population diagnosed all four lesions, followed by 12.5%, 25%, 0.06% and 0% diagnosed three out of four lesions, two out of four, one out of four lesions and none of them obtained zero marks. Statistical analysis of the results was done. The statistical method used was the Independent t-test, which showed the p-value of 1.000. So, there is no significant difference between the two study groups was found.

The questionnaire study results regarding how the study population diagnosed the given histopathology lesions. For the Group one who underwent Game-based learning method shown in Figure 2. The figure revealed that 81.25% of the study population diagnosed the first slide 'Fatty Liver' by its pathological features and 18.75% diagnosed by means of patterns on the section. 100% of the study

population diagnosed the slide two 'Acute Appendicitis' with morphological orientation and none for pattern orientation. For the diagnosis of slide three 'Tuberculous lymphadenitis' 100% were oriented morphologically and none for pattern orientation. The slide four was diagnosed with morphological orientation by 87.5% and 12.5% with pattern orientation. This showed that the study population was highly oriented to the morphological features at an average of 92.2% for making the diagnosis of given four lesions. At a minimum of 7.8% were still oriented to patterns.

For the Group two as shown in Figure 3, 87.5% of the study population diagnosed the first slide 'Fatty Liver' by the patterns on the section and 12.5% diagnosed by means of pathological features that is morphological features on the histopathology section. 100% of the study population diagnosed the slide two 'Acute Appendicitis' with morphological orientation and none for pattern orientation. For the diagnosis of slide three 'Tuberculous lymphadenitis', 100% were oriented on the patterns and none for morphological orientation. The slide four was diagnosed with morphological orientation by 37.5% and 62.5% with pattern orientation. This showed that the study population was highly pattern/design oriented for making the diagnosis at an average of 62.5% and only 37.5% of the study population was oriented morphologically. This showed that understanding of the morphological features properly for a particular lesion is higher in image-oriented game based slide reading method than the conventional microscopy method

In a study by Min Hyung Kim *et al.*, was focused on the Laboratory education on pathology, among the undergraduate medical students. In which a comparison of two methods (Traditional analog microscopy alone and virtual microscopy along with traditional method) of slide reading as post teaching survey was done. The study results showed that the students preferred Virtual microscopy along with traditional method more than the traditional analog microscopy method. This is correlated with our study that the students' performance in slide examination is at a better level than the glass slide method. The students identified the morphological features of the lesion perfectly (Kim MH, *et al.*, 2008).

Another study by Hanna MG *et al.*, compared three modalities of cytopathology screening and interpretation, i) Direct glass slide viewing, ii) Digitalised images (digitalized by Virtual digital pathology slide scanner) and iii) Panoramic digital images which were created manually. The results of that study showed that there was no statistical difference in the diagnostic concordance between the

three modalities of cytopathology slide screening and interpretation and there was the similar expression of user's diagnostic confidence (Hanna MG, *et al.*, 2017). Our study also showed that there is no significant difference between the two learning methods. This may be because of the subjective analytical pattern of slide spotter exams. Instead of the statistical insignificance, the group which learned through the image oriented game based slide reading method understood the histopathological features perfectly and even they could do the diagnosis without any prior focusing of the slides.

Romero E, *et al.*, 2007 studied the utilization of digital image based histopathology practical classes with access to both students and the facilitators for the future revision purpose. The images were given along with accompanying supporting documents for further clarification. Comparison between the classical light microscopy method and the image based method showed that the students' performance was higher in image-based method. This is well correlated with our study that the students could easily pick out the salient features of the histopathological features in their practical slide examination.

A survey-based study done by McCready *et al.* on second-year dental students showed that 92% of the students preferred Digital Microscopy over the light Microscopy, 98% agreed that digital microscopy enhanced their learning and 97% agreed that it allowed for greater collaboration among peers (McCready ZR and Jham BC 2013). In this study, we proved the same that the students learning efficiency through image oriented game based slide reading is higher than the conventional light microscopic pathology teaching method.

## CONCLUSION

The image oriented game based pathology slide learning helps the undergraduate students to diagnose the pathology lesions with proper knowledge of morphological features than the conventional slide learning method, which is mainly pattern oriented. Though it is a very complicated procedure, the game based slide learning method is fun, creative and involves a majority of the student's attention towards morphological features of any pathological lesions. The Image oriented game based slide reading methodology is an innovative teaching method in Pathology, under the second year of Dental and Medical professional curriculum, which makes the Undergraduate understand and orient better to the pathological lesions clinically and histopathologically.

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