

Virtual microscopy: Here to stay?

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ABSTRACT

Background: Histology has been traditionally taught using microscopes and glass slides with stained tissues. However, traditional approaches to teaching may not address the learning preferences of the millennial students. Advancements in technology have provided new opportunities for teaching and learning in medical education. Digital histological images are increasingly being used to teach histology to medical and dental students of late. The significance and feasibility of use of the virtual microscope and virtual images warrant reflection. **Objectives:** To collect and review studies from published medical literature. To compare the experience in our institution with data available from the literature review. **Materials and Methods:** A review of published medical literature on the implementation, strengths and limitations, and impact of the use of virtual microscopy (VM) has been conducted. The findings have been compared with the experience in our institution. **Result:** Most of the studies that evaluated students' learning outcomes in histology after being taught using VM have reported significant improvements in the students' performance. Our experience has been the same. **Discussion:** In comparison with the traditional microscope-based approach of teaching histology, VM is at least as effective if not more for learning tissues at the microscopic level. The advantages of adopting VM far outweigh its limitations. **Conclusion:** A judicious blending of traditional and technology based instruction would be beneficial to the tech-savvy generation of medical students.

Key words: Histology, Microscopes, Virtual images

*In days of old, those far off times
Of high romance and magic,
A toad was an enchanted prince,
A transformation tragic.
Today the toad is studied as
A scientific topic
No prince is found, although we look
With vision microscopic.
And yet, the prince is there-he's there
As clearly as can be.
Forget your microscope, my friend,
And use your eyes to see!*
- Anon

INTRODUCTION

Histology, the study of the microscopic anatomy of tissues is commonly performed by examining tissues

under a light microscope after the tissues are sectioned, stained, and mounted on glass slides. This method of histology instruction is facing challenges, as curricular reforms have reduced the time and number of faculty available for teaching-learning the subject. This is compounded by the dawning of a new millennium, the age of the digital citizens. Over the last decade, new technological advances have transformed histology teaching from the traditional light microscopes to digital histological images, referred to as "virtual microscopy (VM)."^[1] Health professional schools in the west have been utilizing computer digital images in their courses involving microscopy.^[2-5]

Several studies indicate certain histology teaching programs have partly incorporated VM while retaining light microscopy for selected aspects of the course while others have made a gradual transition from light

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microscopy to VM.^[6-8] In our Institution, we have retained the traditional method of teaching histology to medical students with the minimum incorporation of virtual histological images for delivering didactic lectures. However, we have transitioned from traditional to VM for our international dental students.

Objectives

1. To collect and review studies from published medical literature
2. To compare the experience in our institution with data available from the literature review.

MATERIALS AND METHODS

Medical Literature search for articles on design, development, and implementation of VM was conducted.

In our institution, VM image acquisition involved digitally photographing tissue sections on microscope slides using a single trinocular microscope with attached LCD projector eyepiece camera (Figure 1). A virtual histology image atlas was created which included annotation of the digitized images (Figure 2). 1st year dental students ($n = 50$) of the Penang International Dental College, Salem were exposed to the virtual histology images during histology practicals, in a virtual laboratory equipped with 25 computer monitors (Figure 3). The students were randomly divided into two groups ($n = 25$). Each group had a session each of the traditional method and VM. The images were projected during the teaching session from the faculty computer. Images could be simultaneously accessed on the student computers through an internal portal. The students were provided with the soft copy of the virtual images. A Computer literacy survey and a pre-use survey regarding computer-assisted learning were conducted for students before they were exposed to VM. Students' perception questionnaire was administered following utilization of VM. Practical tests were conducted as part of the formative assessment for students following exposure to the traditional method as well as VM. The tests were conducted with microscopes and slides and on computers for the groups, respectively.

RESULTS

In a study done to assess the effectiveness of an electronic histology tutorial (EHT) as a mode of learning, comparison of performance on two term tests for an EHT class of 69 first year dental students and five prior classes ($n = 347$) who learned by traditional methods



Figure 1: Trinocular microscope

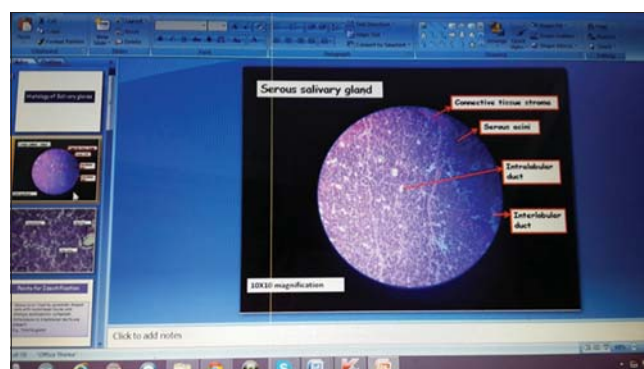


Figure 2: Digitized and annotated histology image



Figure 3: Histology laboratory with 25 computer monitors

were analyzed. The EHT group performed significantly better on both the general histology and oral histology term tests than the 5 prior control years.^[9]

Several other studies have documented improvements in student grades in histology when the approach for teaching this topic was modified from traditional utilization of microscopes to a virtual histology course.^[10-13]

Our experience has been similar to other studies. The test scores of students exposed to VM was better than those taught with traditional microscopy. The computer literacy survey conducted before the students were taught using VM indicated 80% of students were familiar with the use of computers for personal communication. Responses obtained from students' perception questionnaire, rated on Likert scale indicated the majority of the students found the virtual lab a comfortable learning environment. They found virtual images were easier to view and understand as compared with conventional images in atlases or under the microscope. The students, however, opined that virtual images should be used as an additional support to concepts presented by the conventional method through a microscope.

DISCUSSION

Advantages of VM

The need to design and develop VM has been felt globally due to rising numbers of the student population, reduction in staff members and the educational advantages of new technologies.^[14] Maintenance of microscopes and slides involves recurring costs for educational institutions,^[1,15] while digitized histological images can be stored and revisited anytime, anyplace by students, and the incremental cost of offering slides to an additional number of students is small.^[13,16-19]

VM is best suited to microscopic anatomy in which the tissues are visually intensive, detail oriented, and difficult to conceptualize. VM produces magnified images of good resolution which can be projected on computer monitors, and hence limitations of visualization of histology sections can be overcome.^[14]

In the study conducted in our institution, evaluation of the effectiveness of VM by comparing test scores of students taught by VM with those taught with traditional methods indicated higher scores for students exposed to VM, which is similar to observations in other studies.^[9] Students' perception of the two methods of teaching-learning indicated students preferred VM to traditional microscopes and slides which correspond to results obtained in other studies.^[20]

Future of VM

The emergence of newer digital technologies in the post-PC era as proclaimed by Steve Jobs, such as iPad and android-based computer tablets add an unparalleled amount of portability and connectivity to

students to enable them to access histology learning materials, 24 × 7. They also provide avenues for interactive learning which are in tandem with how today's students prefer to learn.^[1]

Limitations of VM

If the virtual slides have static images of tissues, then the students would find it difficult to identify the same tissues if they were to be focused in a different field. This observation is similar to the results obtained by a study which quotes that if computer applications are used alone, students would just memorize the one picture presented and lose the ability to identify the same structure if focused from a different vantage point.^[21]

It has been opined by various authors that light microscope enhances histological knowledge of students through acquisition of the skill of operation of the microscope. This would stand them in good stead when they progress to the study of subjects such as pathology and microbiology which necessitate the use of microscopes.^[1,22,23]

CONCLUSION

It is evident from our study and information available in the medical literature that VM is an acceptable and feasible method of teaching histology practicals and helps the students to achieve learning efficiency as well as better learning outcomes. A judicious blending of traditional and technology based instruction would be beneficial to the tech-savvy generation of medical students. Periodic modifications in the learning resources, i.e., virtual histological images and the annotations are essential to update them. We also need to move forward and develop teaching modules with VM, which employ smartphones and tablet computers, devices which emphasize portability and connectivity to enable delivery of electronic learning materials to students anytime and anywhere so that students could learn at their own pace.

REFERENCES

1. Hortsch M. From microscopes to virtual reality – How our teaching of histology is changing. *J Cytol Histol* 2013;4:e108.
2. Cunningham CM, Larzelere ED, Arar I. Conventional microscopy vs. computer imagery in chiropractic education. *J Chiropr Educ* 2008;22:138-44.
3. Goubran EZ, Vinjamury SP. Interactive atlas of histology: A tool for self-directed learning, practice, and self-assessment. *J Chiropr Educ* 2007;21:12-8.
4. Michaels JE, Allred K, Bruns C, Lim W, Lowrie DJ Jr, Hedgren W. Virtual laboratory manual for microscopic anatomy. *Anat Rec B New Anat* 2005;284:17-21.

5. Glatz-Krieger K, Spornitz U, Spatz A, Mihatsch MJ, Glatz D. Factors to keep in mind when introducing virtual microscopy. *Virchows Arch* 2006;448:248-55.
6. Krippendorf BB, Lough J. Complete and rapid switch from light microscopy to virtual microscopy for teaching medical histology. *Anat Rec B New Anat* 2005;285:19-25.
7. Heidger PM Jr, Dee F, Consoer D, Leaven T, Duncan J, Kreiter C. Integrated approach to teaching and testing in histology with real and virtual imaging. *Anat Rec* 2002;269:107-12.
8. Blake CA, Lavoie HA, Millette CF. Teaching medical histology at the University of South Carolina School of Medicine: Transition to virtual slides and virtual microscopes. *Anat Rec B New Anat* 2003;275:196-206.
9. Rosenberg H, Kermalli J, Freeman E, Tenenbaum H, Locker D, Cohen H. Effectiveness of an electronic histology tutorial for first-year dental students and improvement in “normalized” test scores. *J Dent Educ* 2006;70:1339-45.
10. Cohen HB, Walker SR, Tenenbaum HC, Spero L. Interdisciplinary, web-based, self-study, interactive programs in the dental undergraduate program: A pilot. *J Dent Educ* 2003;67:661-7.
11. MacPherson BR, Brueckner JK. Enhancing the dental histology curriculum using computer technology. *J Dent Educ* 2003;67:359-65.
12. Cotter JR. Laboratory instruction in histology at the University at Buffalo: Recent replacement of microscope exercises with computer applications. *Anat Rec* 2001;265:212-21.
13. Harris T, Leaven T, Heidger P, Kreiter C, Duncan J, Dick F. Comparison of a virtual microscope laboratory to a regular microscope laboratory for teaching histology. *Anat Rec* 2001;265:10-4.
14. Greenhalgh T. Computer assisted learning in undergraduate medical education. *BMJ* 2001;322:40-4.
15. Farah CS, Maybury T. Implementing digital technology to enhance student learning of pathology. *Eur J Dent Educ* 2009;13:172-8.
16. Trelease RB, Nieder GL, Dørup J, Hansen MS. Going virtual with quicktime VR: New methods and standardized tools for interactive dynamic visualization of anatomical structures. *Anat Rec* 2000;261:64-77.
17. Downing SW. A multimedia-based histology laboratory course: Elimination of the traditional microscope laboratory. *Medinfo* 1995;8:1695.
18. Lehmann HP, Freedman JA, Massad J, Dintzis RZ. An ethnographic, controlled study of the use of a computer-based histology atlas during a laboratory course. *J Am Med Inform Assoc* 1999;6:38-52.
19. McLean M. Introducing computer-aided instruction into a traditional histology course: Student evaluation of the educational value. *J Audiovis Media Med* 2000;23:153-60.
20. Lei LW, Winn W, Scott C, Farr A. Evaluation of computer-assisted instruction in histology: Effect of interaction on learning outcome. *Anat Rec B New Anat* 2005;284:28-34.
21. Deniz H, Cakir H. Design principles for computer-assisted instruction in histology education: An exploratory study. *J Sci Educ Technol* 2006;15:399-408.
22. Weaker FJ, Herbert DC. Transition of a dental histology course from light to virtual microscopy. *J Dent Educ* 2009;73:1213-21.
23. Pratt RL. Are we throwing histology out with the microscope? A look at histology from the physician’s perspective. *Anat Sci Educ* 2009;2:205-9.

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