Review Article

Teaching Histology Using Digital Slides in a Virtual Classroom

Abu Sadat Mohammad Nurunnabi[1], Mohsin Khalil[2], Abdul Alim[3], Anjuman Ara Sultana[4], Sharmin Rahman[5], Shuchana Chakma[6]

Abstract

In the Phase-I of MBBS programme in Bangladesh, anatomy teachers have been using glass slides and standard microscopes along with a brief review of the lectures with projection slides during practical education and training in histology in all medical colleges for decades. However, during the COVID-19 pandemic days, due to closure of all medical colleges, medical education embraced virtual platforms. We tried to build a repository of digital histology slides from our collections in histology laboratory and many free web digital sources; we also adapted our lesson plans that fit online platform. Digital images (derived from microscopic glass slides and other web-based resources) shown on the computer screen had panning and zooming capabilities that simulates moving the stage and the low to high power magnification of an optical microscope. Each digital image had also a thumbnail image from which the students could always refer to when viewing the digital slides at a higher magnification for proper orientation of histologic sections. Digital imaging technology was involved there to acquire, manage, and analyze high-resolution digital images of tissue samples on slides. A revolutionary conversion happened in teaching histology from using traditional microscopy on glass slides to digital slides (first ever in our country); digital slides can be viewed, stored, and analyzed using computerized systems anytime, anywhere. Integration of digital technologies in virtual classroom into histology teaching and learning (in anatomy curriculum) allowed teachers and students to experience numerous benefits, e.g., enhanced and active learning, more accessibility, reduction in time and resource consumption, and online collaboration. However, some of the challenges we faced are excess time and efforts, required technical skills, infrastructure and logistic support from the institutions, and motivation among teachers and students.

Keywords: *Anatomy; Digital Technology; E-learning; Histology; Medical Education.*

Delta Med Col J. Jul 2022;10(2):77-82
DOI: https://doi.org/10.3329/dmcj.v10i2.81740

Introduction

Anatomy is one of the core subjects taught in the Phase-I of MBBS programme in Bangladesh. This pre-clinical phase is the major building block for the medical students in terms of acquiring basic

Author information

1. Assistant Professor, Department of Anatomy, OSD, Directorate General of Health Services (DGHS), Dhaka, Bangladesh.
2. Assistant Professor, Department of Anatomy, Mymensingh Medical College, Mymensingh, Bangladesh.
3. Assistant Professor, Department of Anatomy, Sheikh Hasina Medical College, Jamalpur, Bangladesh.
4. Assistant Professor, Department of Anatomy, Shaheed Suhrawardy Medical College, Dhaka, Bangladesh.
5. Lecturer, Department of Anatomy, Ad-din Women's Medical College, Maghbazar, Dhaka, Bangladesh.
6. Lecturer, Department of Anatomy, Marks Medical College & Hospital, Dhaka, Bangladesh.

Correspondence: Dr. Abu Sadat Mohammad Nurunnabi. e-mail: shekhor19@yahoo.com

knowledge, skills and competences in medical science.[1] Histology, or microscopic anatomy, remains one of the most fundamentals of anatomical sciences taught in the early years of a medical course across the globe.[2] In our anatomy departments, histology education and training provides medical students not only with basic knowledge and understanding of the normal structure ofthe human body at microlevel but also the functions relating to those structures.[2,3] Moreover, better understanding of normal tissue architecture or cellular morphology regarded as a prerequisite for better understanding of their anomalies or disruptions (i.e., pathology), which is taught in later years.[2,3]

During the recent COVID-19 pandemic, abrupt closure of all the medical colleges in different countries in order to prevent spreading of virus and ensure health and safety of the medical students led to severe disruptions in medical education.[4] Ours was not an exception. Simultaneously, to cope with the situation, medical teachers and students of Bangladesh experienced the historical event of shifting to an unprecedented online (virtual) environment from their traditional face-to-face teaching in the classroom or laboratory. Thus, the pandemic situation led us to embrace digital technologies to create E-learning environment and adapt our teaching style, lesson plans and assessment accordingly.[5] In our settings, we generally arranged synchronous (live) online lectures (E-learning) through video conferences and virtual classrooms along with other departments. Besides, we tried to build a repository of digital histology slides from our collections in histology laboratory and many free web digital sources; we also adapted our lesson plans that fit online platform, following several evidence form the western countries.[6-10] Teaching and learning in histology was a challenge for us, as it usually involves a laboratory placement and practical training. The main objective of histology teaching and learning is the understanding of structural level organization of tissues in cells, intercellular substances, and organs, using light microscopes and prepared tissue samples on glass slides.[3,6] We took the initiatives to go digital for the purpose. Digital histology refers to using digital imaging technology to acquire, manage, and analyze high-resolution digital images of histological specimens, such as tissue samples or microscope slides. This process involves converting traditional glass slides into digital slides, which can be viewed, stored, and analyzed using computerized systems.[6-10] We prepared digital histology slides and started to teach histology by using those digital slides in a virtual classroom. This review paper describes our experience of such an experimental and innovative teaching and learning strategy as well as its advantages and the challenges we encountered.

Virtual Histology Classroom: Our Experience

Generally, students often face challenges with histology classes under anatomy curriculum due to the complex nature of the subject with overwhelming volume of knowledge, difficulties in visualizing the structures and navigating and identifying those in tissue specimens, limited exposure to learning materials, and lack of clinical relevance, as it is taught in the pre-clinical phase.[8,10] During the recent COVID-19 pandemic, the teaching of histology increasingly relied on digital resources instead of traditional face-to-face teaching in histology laboratories.[10] We also chose to treat this shift to the online format as an opportunity rather than a threat to the conventional teaching of microscopic anatomy (histology). Abandoning the use of conventional microscopes and glass slides to educate and train our students, we decided to rely on virtual microscopy to facilitate teaching and learning in those areas, and to radically redesign practical classes for teaching of histology based on our online platform using 'zoom'. Virtual microscopy was arranged with the digital images of histology slides on a computer screen have panning and zooming capabilities simulating moving the stage and the low to high power magnification of an optical microscope.[10-13] The digital image has a

thumbnail image from which the students can always refer to when viewing the digital slides at a higher magnification for proper orientation of histologic sections.[10-13] Unlike the sophisticated digital histology library/archive used in the developed countries,[8,10-15] ours one was simple and easy to handle and mostly teacher-led (Fig. 1). However, students were supplied with free downloadable contents (lectures and slides) for their subsequent personal reading and practice. Each page (slide) consists of an image with a title and a descriptive text included beneath it. To the right of the image, there were labels indicating the structures identified in the image, and a new descriptive text is displayed beneath the image of that specific structure.[12-15] There was adjusted resolution when students zoom in to observe through ×40, ×100, or even much higher magnifications, which was more enhanced than that of light microscopy used in the laboratory classroom.

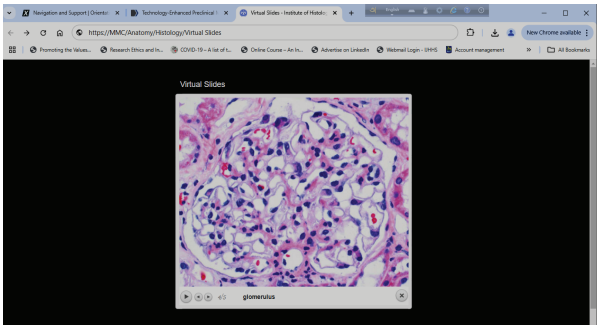

Fig. 1: Digital histology slides shown in virtual tutorial class (teacher led lecture and discussion)

Careful coordination of the histology lectures (e.g., urinary system) and presentations of histology slides (e.g., kidney, ureter and urinary bladder) ensures that a lecture on the structural features and functions of an organ or system precedes the exercise (identification and discussion on the histology slides). Digital histology contents given to the students provide an open and unconventional (new to our students beyond their experience of histology books and lecture sheets) educational resource that served as a mini digital atlas of histology with descriptive text.[13-16] After finishing a whole system, we also arranged in class questions and answers (Q&A session) and peer discussion. Multiple-choice questions (MCQ) tests and short answer questions (SAQ) tests (as part of our summative assessment) were arranged,[17] for the first time in our curriculum using digital slides featuring identifying the tissue sample with identifiable characteristics, naming the structures labelled, describe their functions, and some clinical correlations following evidence from the western countries,[6-8,12-15] as well as from low-resource settings.[16-18] We also received students' feedback to see the prospect and challenges of this technology integration in anatomy teaching and learning (also broadly in medical education), as done in other countries.[12-17]

Advantages

As we mentioned earlier that we have been using glass slides and standard microscopes along with a brief review of the lectures with projection slides as our conventional practical training in histology for decades. However, integration of digital technologies like virtual classroomsin to our medical education settings and digital histology slides in anatomy teaching allowed students and educators to experience numerous benefits. They are as follows:

1. Enhanced learning opportunities: High-resolution digital images give students an in-depth understanding of normal as well as possible abnormal conditions (pathology), allowing them to examine and analyze microscopic details of any tissue or organ that might not be easily visible with traditional microscopy and glass slides.[6,8,12-16,18-20]

2. Active learning: Our digital histology platform offered interactive features such as annotations and zooming capabilities, enabling students to engage with the specimens actively. These customizable capabilities and teaching approach helped them develop critical thinking,

self-reflection, and problem-solving skills.[8,10,12-15,17] These interactive experiences did complement the learning process tremendously. Besides teaching normal histological structure, we gathered some clinical and rare cases in our resource pool that could be viewed by the students for better understanding which ultimately led toproviding high-quality histology (anatomy) education. Such student engagement in a virtual classroom is very promising.[20,21] Better engagement not only makes teaching more fun, more engaging, and more rewarding, but also it has been shown to have critical impacts on students. When students display high levels of behavioural, emotional, and cognitive engagement, they are more likely to excel academically, form a stronger sense of connection with their institution, and also have a more positive sense of social-emotional well-being, which is also crucial for medical education.[12-17,22-25]

3. Improved accessibility and reduced time and resource consumption: The students were provided with the downloadable lecture and digital histology slides made their education more accessible regardless of their geographical location. Moreover, they could use it for personal reading and practice whenever they want. The process also allowed instructors and students become flexible and unbound from traditional thinking of microscopes, glass slides, and laboratory classroom in histology education and training. This also reduced the amount of time spent to physically attend lab/class. Moreover, it cut down need for light microscope, glass slides and laboratory materials and other printed materials, and helped us reduce resource consumption in medical education.[6,8,10,12-16,21,24]

4. Online collaboration: Digital slides could be easily shared among students by the instructors and enabled collaborative discussions, Q&A sessions, and peer feedback. Such collaboration helped promotion of student-faculty interaction and development of higher-level thinking, oral communication, self-management, and leadership skills. Overall, all those also fostered a sense of community and encouraged active participation.[16,18-24] Moreover, it helps to collaborate with other specialties (e.g., physiology and pathology) to create integrated teaching and learning and better understanding of the disease process.[19-21] Digital histology helps us promote flipped classroom approach in anatomy teaching and learning.[25]

Challenges

Challenges that we faced during the development and implementation of such innovative digital histology settings in the Department of Anatomy included physical, technical and operational factors. They are as follows:

1. Excess time consumption and efforts: Scanning histology slides, compilation, adding texts and labelling and creating an archive required extra time and efforts for the anatomy educators.[6,8,12,19]

2. Limited or no technical skills (computer application in teaching and learning): Many of our medical teachers lack basic computer skills to handle online teaching and learning through virtual histology slides and conduct effective lessons for the students let alone create a digital archive of histology slides to teach now and later.[13,16-18,22]

3. Resource-poor infrastructure and lack of logistic support from the institution: Ours is a resource-poor country and not all of the medical colleges are in a position to ensure seamless online education and lacks structural and logistics for the purpose. For example, no medical college could adopt any learning management system (LMS) or afford any computer-assisted education infrastructure like free internet (Wi-Fi facilities), supplying tablets to the teachers and the students.[16,23]

4. Lack of motivation among teachers and students: Many of the anatomy educators were found conservative and very skeptical about conversion of traditional microscope-slide based laboratory teaching methods in histology to a solely digital platform.[12,14,17,24] They also lamented the loss of microscopy skills. Although the students were devoted to online learning and felt engaged in such activities, some thought the process unsustainable. Most of the educators and students believed that the basic skills to operate a conventional light microscope quite important for the students because viewing real tissue under the light microscope helps long-term memorization, increase confidence in microscopy skills, and create positive student-teacher interactions and relationships.[18-21,23,24] Apart form that, some educators believe that this type of online format is only effective in small-group teaching.[25]

Conclusion

The COVID-19 pandemic encouraged medical education in our country towards a transition into technology-infused teaching and learning. Department of anatomy in different medical colleges in our country are not exceptions to that. In our experience, we observed that teaching and learning in histology using digital slides in a virtual classroom is promising and sustainable; it is also amenable ranging from an individual to small-group teaching and even applicable to a large-group tutorial. Moreover, it facilitates active learning by keeping students engaged which remains a common challenge in histology education and training. In near future, by removing the barriers, it could be adjusted to regular curriculum to produce better outcomes in histology education and training.

References

1. Bangladesh Medical & Dental Council (BM&DC) [Internet]. Bachelor of Medicine & Bachelor of Surgery (MBBS) Curriculum in Bangladesh. 2021 December [cited 2021 Dec 30]. Available from: https://www.bmdc.org.bd/docs/curriculum/2021/2.PhaseI.pdf.
2. Cui D, Moxham BJ. A core syllabus for histology within the medical curriculum – The cell and basic tissues. Clin Anat. 2021;34(3):483-95.
3. Ahmed R, Shamim KM, Talukder MHK, Parvin S. Light microscopy for teaching-learning in histology practical in undergraduate medical education of Bangladesh – A teachers' perspective. South-East Asian J Med Educ. 2018;12(1):26-31.
4. Bentata Y. COVID 2019 pandemic: A true digital revolution and birth of a new educational era, or an ephemeral phenomenon? Med Educ Online. 2020;25(1):1781378.
5. Khanom M, Hoque A, Sharif PI, Sabuj MU, Hossain MA. How were the online classes in undergraduate medical teaching during COVID pandemic? Students' views of a non-government medical college in Bangladesh. Bangladesh J Med Educ. 2020;11(2):3-13.
6. Cotter JR. Laboratory instruction in histology at the University at Buffalo: Recent replacement of microscope exercises with computer applications. Anat Rec. 2001;265(5):212-21.
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(2):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(1):196-206.
9. Hortsch M. From microscopes to virtual reality – How our teaching of histology is changing. J Cytol Histol. 2013;4(3):e108.
10. Darici D, Reissner C, Brockhaus J, Missler M. Implementation of a fully digital histology course in the anatomical teaching curriculum during COVID-19 pandemic. Ann Anat. 2021;236:151718.
11. 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(1):10-14.

12. 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(1):19-25.

13. Paulsen FP, Eichhorn M, Bräuer L. Virtual microscopy – the future of teaching histology in the medical curriculum? Ann Anat. 2010;192(6):378-82.

14. Campbell G, Demetriou LA, Arnett TR. Virtual histology in the classroom and beyond. Med Educ. 2010;44(11):1124-25.

15. Daniela B, Melisa G, Luis AJ, Cristian A, Jorge T, Rosario M, et al. Academic achievement and perception of two teaching methodsin histology: Light and digital microscopy. Pilot study. Int J Morphol. 2018;36(3):811-16.

16. Thintharua P, Dharmasaroja P. Histology study in undergraduate medical education. Ramathibodi Med J. 2020;43(3):34-40.

17. Fatima SS, Idrees R, Jabeen K, Sabzwari S, Khan S. Online assessment in undergraduate medical education: challenges and solutions from a LMIC university. Pak J Med Sci. 2021;37(4):945-51.

18. Rojas M, Montiel E, Montiel J, Ondarza A, Rodríguez H. Comparative study between traditional teaching methods and computational methods in the human histology. [Article in Spanish] [Abstract]. Rev Chile Anat. 1999;17(1):81-85.

19. Chapman JA, Lee LMJ, Swailes NT. From Scope to Screen: The Evolution of Histology Education. In: Rea PM. ed. Biomedical Visualisation. (Advances in Experimental Medicine and Biology Series, Vol. 1320). Cham, Switzerland: Springer; 2020. p.75-107.

20. Higazi TB. Use of interactive live digital imaging to enhance histology learning in introductory level anatomy and physiology classes. Anat Sci Educ. 2011;4(2):78-83.

21. Pinder K, Nimmo M, Cooper D, Allard M, Yule H, Maurice S. Integrated histology and pathology education in the renewed UBC M.D. undergraduate program. FASEB J. 2017;31(S1):583.14.

22. Bloodgood RA. Active learning: A small group histology laboratory exercise in a whole class setting utilizing virtual slides and peer education. Anat Sci Educ. 2012;5(6):367-73.

23. Deniz H, Cakir H. Design principles for computer-assisted instruction in histology education: An exploratory study. J Sci Educ Technol. 2006;15:399-408.

24. Simok AA, Hadie@Haji SNH, Manan@Sulong HA, Yusoff MSB, Noor MNF, Asari MA, et al. The impact of virtual microscopy on medical students' intrinsic motivation. Educ Med J. 2019;11(4):47-59.

25. Aristotle S, Subramanian S, Jayakumar S. Effectiveness of flipped classroom model in teaching histology for first-year MBBS students based on competency-based blended learning: An interventional study. J Educ Health Promot. 2021;10:152.