



Digital slides in histopathology education

How does digital technology aid histopathology training?

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In this article, Dr Bethany Williams explores some of the potential uses and benefits of digital slides in teaching and training, and shares some practical tips on how to integrate whole-slide images into educational practice.

Digital pathology adoption continues to flourish in histopathology departments across the world, transforming clinical service delivery. Digital slides are a versatile diagnostic tool that can also add value to the educational endeavours of a department, supporting a variety of learners including undergraduate students, doctors in training and those pursuing continuing professional development needs.

Digital slides offer numerous potential advantages over the use of glass slides in education.

- **Accessibility** – digital slides can be accessed by multiple viewers in multiple locations simultaneously, allowing synchronous and asynchronous sharing of learning materials, and replication of rare teaching cases and sets. Digital slides can be overlaid with text and audio descriptions to support the needs of a variety of learners.
- **Efficiency** – technical competence in viewing slides can be obtained far more quickly using the digital microscope versus conventional light microscopy, which is particularly important for undergraduate learners. Slide sets can be viewed and circulated with ease across multiple locations.
- **Cost** – online sharing of digital teaching materials allows for economies when delivering virtual teaching across multiple sites. There is no need for additional glass slide replication and recuts to create teaching sets.
- **Pedagogical advantages** – the layout of the digital slide, with the very low power view and thumbnails, allows learners to relate the screen view to the specimen as a whole. Annotations and labels can guide the learner through the content, while side-by-side digital slide viewing

and synchronous evaluation with radiological/clinical images aids appreciation of clinico-pathological correlation.

Digital slides in undergraduate education

Since the 1990s, there has been a reduction in time allotted to pathology and basic sciences teaching in favour of increased clinical exposure. This has combined with a shift from departmentally-organised didactic teaching towards integrated and systems-based curricula, with more emphasis on case-based and problem-based learning. Digital microscopy laboratories, accessed via personal devices or in university computer laboratories, have gradually replaced fixed training facilities with standard optical microscopes.

Digital slides with links to additional resources, including macroscopic and radiological images, enrich the learning experience. Small doses of histopathology, in the form of digital slides, can be incorporated easily into systems-based lectures that may not have included microscopic material previously. Histopathology can also be introduced in small group teaching environments, where medical students preview curated digital slide sets that are then discussed with a facilitator. Students are given a patient presentation and then work the slides up virtually, ordering lab tests, imaging and biopsies, and receiving results in real time. These small-group activities encourage increased participation and help foster a sense of community.

Finally, digital slides can open up interest in histopathology careers by broadening access to electives or clerkships in histopathology. One such scheme blossomed during the COVID-19 pandemic in Seattle, where an unprecedented number of students were able to attend consultant pathologist sign-out sessions via Zoom. Annotation functionality permitted users to draw on the screen, so that educators could highlight key features and demonstrate findings in real time.

Digital slides in postgraduate education

Digital slide technology adoption in postgraduate education has lagged behind adoption for undergraduate teaching, mirroring adoption rates for primary diagnostic practice in clinical settings. Practice differs widely from country to country, and from city to city, in terms of access to and usage of digital slide images for histopathology service delivery. Many departments still depend on the use of glass slides and conventional light microscopy. Proficiency in digital pathology techniques is not a core component of the RCPATH postgraduate curriculum for histopathology. During this period of digital transformation, trainees still need to balance use of digital slide technology with hands-on experience of traditional microscopy and acquisition of technical skills for glass slide diagnosis, including Koehler illumination.

In non-digital histopathology departments, curated digital selections can be accessed by trainees and trainers to aid learning, while in departments with an evolving clinical archive of live patient cases, trainers are able to direct trainees to the most relevant digital cases for their individual learning needs. They are also able to share their current real-world workload with the trainee, without delaying final diagnosis for the patient; both trainee and trainer can review the same case synchronously, on separate workstations, and share their impressions of the case during dedicated feedback and discussion sessions.

Digital slides and continuing professional development

Digital slides can provide a practical means for pathologists to maximise their continuing professional development (CPD) opportunities. Topography-specific, online CPD events stream digital slides online and have successfully incorporated digital-slide-based pre- and post-event self-assessment cases to consolidate learning. External quality assurance (EQA) materials shared in the format of digital slides, hosted by the [University of Leeds Virtual Pathology website](#), allow hundreds of pathologists to share rare, informative cases for discussion and consensus review.

Tips for incorporating digital slides into educational practice

To be effective, educational digital slides should be interesting, challenging and authentic. Care should be taken to ensure that the level of difficulty and complexity of cases matches the needs of participants. For undergraduate medical students and new starters in histopathology specialty training, clear, unambiguous examples of common pathologies should be presented, with suitable interactive labels and annotations to aid identification of key features.

More advanced learners, including pathologists in training, should be presented with cases of increasing rarity and difficulty. They also need to review an appropriate number of normal slides, and slides with dual pathologies or unusual features. Table 1 documents how digital slide use can be tailored to different learner groups (undergraduates, trainees and CPD users). Digital slide software allows trainers to enable or block signposts, labels and annotations for different users of the same digital slide with differing levels of ability and confidence.

Case-based learning (CBL) can be utilised for both undergraduate and postgraduate histopathology education. Small group teaching settings allow students to explore clinico-pathological correlation and how the medical context can affect the histopathological

differential diagnosis. Digital slides should be presented alongside relevant medical history and multi-disciplinary assessment.

Unlike undergraduate students, postgraduate students in histopathology departments must conduct the majority of their training individually, using self-directed techniques. In this type of learning environment, case lists and digital slide links can be circulated to be reviewed by learners individually and fit their clinical timetable. Cases can then be discussed at regular group meetings, led by a facilitator who ensures the most salient features of the case have been appreciated by the group, and leads discussion of ambiguous aspects of the clinical context and differential diagnosis. Cases should come accompanied by information that mimics the quality and quantity of information provided in clinical requests for histopathology assessment (and in some circumstances the lack of it!), and should utilise real-world nomenclatures, acronyms and coding systems commonly used in local clinical practice.

Table 1. Tailored use of digital slides for different types of learner.

	Types of case	Enhanced digital features	Types of learning experience
Undergraduate	Unambiguous examples of common pathologies Curated, anonymised digital slide sets	Interactive labels and annotations Hypertext links to further resources including glossary of terms	Didactic lectures Small group/special study module teachings Self-study material (digital textbook)
Postgraduate (pathologist trainee)	More complex pathologies, typical and non-typical examples, inclusion of laboratory and digital artefacts A mixture of curated anonymised training slide sets and live cases	Interactive labels and annotations Hypertext links to other digital slides illustrating alternative presentations of the same pathology	Didactic lectures/large group teaching sessions Small group and individual teaching

Continuing professional development	Challenging areas of diagnosis with high levels of intra-observer variability in diagnosis	Screen sharing with peers and experts	External quality assurance schemes Intra- and interdepartmental case discussion
Adapted from Williams (2004). ¹			

It can be useful to ask trainees to rate their confidence in their diagnosis and assessment of a case to give an indication of how certain the trainee is in their skills, and how close they are to achieving sufficient comfort with a specimen or case type to independently sign out a diagnosis to a patient. These confidence ratings can be reviewed with the trainee's educational supervisor to gauge whether a trainee is under- or over-confident, and to track progress in different topographies and diagnostic categories.

The flexibility and transferability of digital slide technology opens up new opportunities for broadening the scope of learners and educators you involve in your teaching sessions. Trainees or students from different regions, with similar specialist learning needs, can be connected and share tailored sessions with experts beyond regional or national boundaries. In this way, we can improve equity of access to training opportunities for junior pathologists, who are no longer limited to the training staff and materials located in a single pathology department.

The use of digital slide training sessions that can be accessed remotely can support the needs of learners who need to work and train more flexibly, including those that work and train less than full-time. One approach would be for trainers to assign links to digital slide cases and meet with small groups of trainees via Microsoft Teams meetings to share desktops, demonstrate how they approached the case and discuss their diagnoses. Trainers are then able to take control of the trainee case and redirect attention to particular features, where necessary.

Digital slides offer a readily adaptable medium for histopathology education that can support quality histopathology education in a range of settings, connecting educators and learners that are geographically or temporally distinct. They can allow us to integrate core histopathology into undergraduate medical curricula efficiently, provide support for doctors in training and allow a flexible approach to continuing professional development for senior clinicians. As digital slide technology becomes more firmly cemented in the day-to-day operations of the clinical histopathology department, the role of the digital slide in education will no doubt be amplified, evolving to incorporate new technologies, including augmented reality technology and artificial intelligence, to improve outcomes for learners.

[References available on our website.](#)

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