"Books versus computers - what does the future of pathology education look like?"

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INTRODUCTION

Pathology, derived from the Greek words 'pathos' and 'logos', translates to the study of suffering - or (with reference to modern medicine), the study of disease[1]. It serves as the interface between science and medicine - supporting the clinical decisions made for diagnostic testing, to developing genetic technologies that can prevent disease[2].

While students learn how to observe the morphologic changes in affected tissues, to make a diagnosis - they may miss the clinical reasoning that is central to this specialty. By finding an effective method to teach pathology, this discipline can transform medical graduates to think logically and scientifically - applying this knowledge throughout their careers to improve patient care.

This essay will analyse the uses of two different platforms (books and computers) in teaching pathology and explore how pathology education may be delivered in the future.

WHAT IS THE ROLE OF BOOKS IN TEACHING PATHOLOGY?

A common teaching style, adopted by many professors and lecturers, is the use of books - reflective of the method that many of them had been taught. With medicine itself using an evidence-based practice approach, it is logical for many educators to prefer using this method - one that has proven to be an important role in students' learning process for many years of education[3].

With the careful curation of books (designed to build on the knowledge students have gained from the previous chapters), students are able to construct mental mind maps - linking knowledge from different sections (of the book), to create a visual representation of the pages they read. This allows students to consolidate their learning, furthering their depth in understanding the material covered[3].

In a study focusing on different methods of reading for university students, 86% preferred reading longer texts in print and 92% found it easier to concentrate (compared to reading on-screen)[4]. Other research on this topic has also shown that many students prefer reading physical books as opposed to e-books. Despite e-books allowing easier access to extra content, it appeared that students prefer using a tactile approach for their learning[5]. The use of a physical text aided the recalling of information in a way that boosts the understanding of the material covered as well as the length of time that they can remember it for[3].

However, with the evolving understanding of pathology (and Medicine as a whole), it is necessary to educate medical students with the most current information - something that may not be

achieved by textbooks alone[6]. Even if books are replaced with the latest edition copies, the costs incurred are expensive and could restrict spending on other resources.

The didactic approach of textbooks often means that the information provided is limited to what the author deems fit. This means that the range covered is not to the extent that can be found in other resources - like computers. This is particularly important when considering the potential cultural and societal biases, which restrict BAME (black, Asian, and minority ethnic) representation - especially since pathologies contrast greatly between caucasian and other ethnic skin types[7]. This lack of diversity (seen in medical textbooks) could restrict patient care - a crucial issue to resolve for future healthcare professionals and must be amended in future pathology education.

WHAT IS THE ROLE OF COMPUTERS IN TEACHING PATHOLOGY?

Given the image-rich content of pathology, computers are often an ideal learning tool, giving access to a vast range of content and current information – thus, overcoming the limits faced when solely utilising books. Medical education itself might be the most widely used application of digital pathology, due to its illustrative purposes and the potential live streaming of slides (for training purposes)[8].

In this digital age, learning via computers allows students to develop skills for future use as part of the workforce. Many clinical pathologists rely on computers for different aspects of patient care - from analysing results of diagnostic investigations to using genetic technology that could

prevent diseases[2]. Digital platforms can display scans with an extremely high resolution - greater than what is achieved by microscopes. This has revolutionised the way pathology can be taught - allowing students (some of whom might not be able to physically sit or concentrate on a microscope for long periods), the chance to explore the material at their own pace and with greater precision by using computer controls rather than manual manipulation of the slides[9]. When combining this with artificial intelligence (AI), research in pathology can also advance. AI analysis could detect morphological patterns that may not be apparent when solely using a microscope - some of these could be pathological features, which were not recognised before and could aid the development of future treatments[10]. By providing early exposure to these platforms, medical students are given more opportunities to develop the skills required and continue enhancing them in their professional careers.

Figure 1: Digital pathology and AI for precision medicine [11]
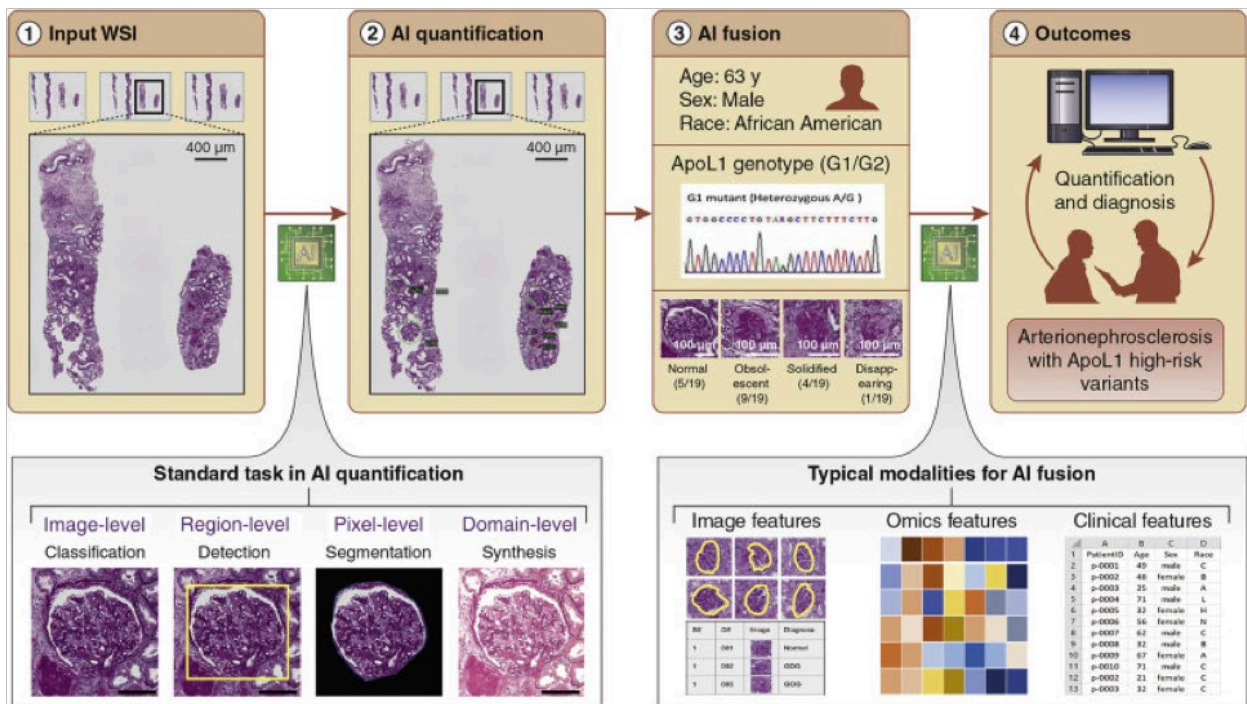
The content being covered in medical school is extensive, distributed amongst multiple topics, with greater emphasis being placed on diagnosis, management, and ongoing support - rather than the fundamental sciences (like pathology)[12]. By using educational web resources (like Pathology Portal), students can access further learning through the guided tutorials and explore the models available[13]. These computer-aided materials can further self-directed study, allowing students to learn beyond the medical school curriculum - especially as the conditions currently taught are few compared to the amount seen in practice.

However, this seemingly inexhaustible set of online resources could risk overexposure. The large volume of information (via digital media), may encourage a fast and shallow read - so there is more keyword-spotting rather than in-depth reading. While digital media causes the brain to process information more quickly, it is also less thorough (as explained in the shallowing hypothesis), meaning fewer details are retained[14]. Additionally, this non-linear approach lacks the structure provided by books, which could potentially make students feel more distracted[14]. This was shown in a study assessing student performance during the COVID-19 pandemic - the results reflected that the shift to remote learning meant many students could not concentrate on their assignments at hand[15].

Even if students were able to stay motivated and focused during online learning, there are other challenges that they may face. Whilst the internet holds the promise of current and up-to-date information, the relevance of the texts may vary[16]. For the future of pathology education, teachers must be able to guide students, ensuring they stay focused as well as directing them towards reliable resources.

HOW DOES THE FUTURE OF PATHOLOGY EDUCATION LOOK?

Education has seemed to shift towards a greater use of computers - catalysed by the COVID-19 pandemic that led to a remote-learning approach[15].

While computers hold a great benefit, aiding self-development and e-learning tools endorsed by major societies (like the Royal College of Pathologists) - books remain an integral part of the learning process[13].

In a study analysing students' performances after reading digitally and in print, the research found that students reading digitally performed well on answering concrete questions, but those reading in print did better on abstract questions[17]. In a discipline like Pathology, an information-gathering approach (utilised in concrete questions), is not enough for acquiring the competencies needed. While a major aspect of pathology is recognising the morphological changes that occur from the disease process, this is not enough to make a diagnosis.

Pathology serves as the interface between science and patient care - correlating the altered structures seen on a slide, with the patient's symptoms and signs[18]. For gaining a deeper understanding to answer these abstract questions, inferential reasoning is required - a skill that is developed via continued use of books.

While computers help supplement the work learnt, books must remain the focal point of pathology education. Books aid in developing better learners - allowing students to connect ideas and process information in a more effective manner than can be achieved via a digital screen. Computers support the foundations taught in written material, keeping the information learnt

relevant - so that the knowledge is current with the latest guidelines and up-to-date with the advancements made.

The future of pathology education is a balance of both books and computers to ensure that medical students graduate with the inquisitive and pioneering nature of pathologists.

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11. **Figure 1:** Digital pathology and AI for precision medicine

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