

Development and validation of digital medical laboratory educational platform

Charity Gichuki¹, Patrick Mutharia^{1*}, Amos Chege¹, Joshua Kibera² and Francis Ondieki³

¹Meru University of Science and Technology.

²The Pathology Network (TPN).

³Aroha Cancer Centre.

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ABSTRACT

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With the rise in whole slide scanner technology, large numbers of tissue slides are being scanned and represented and archived digitally. While digital pathology has substantial implications for telepathology, second opinions and education, there are also huge research opportunities with this new type of digital data. Accessibility to large digital repositories of tissue slides is a huge potential educational resource for medical students and pathology residents. In addition to education of medical students and residents, and clinical adoption, digital pathology has been transformative for computational imaging research. Many universities also do not have active pathology laboratories which are necessary in providing a steady flow of real life cases for medical training and

research. Therefore, this project aimed at designing and validating a digital medical laboratory educational platform where learners could access the virtual slides from their individual student portals irrespective of where they log in from. With the use of a digital slide scanner, physical slides from the manual laboratory repository were scanned and stored in the cloud in digital format. The two platforms of both institutions were integrated so that the students' online leaning portal was in sync with the Pathology Network's digital repository. Once the integration was successful, the students were able to access and interact with the learning materials and virtual slides for Cytology and Cytological Stains which was the scheduled topic for teaching and learning. The study recruited thirty five students from Meru University of Science and Technology pursuing undergraduate studies in Medical Microbiology. Majority of the students (33 out of 35; 94.3%) indicated that digital pathology enhanced their understanding of the topic of study due to availability of virtual slides with ease and at any time of day. All students (35 out of 35; 100%) felt that digital pathology teaching was beneficial to them as Medical Microbiology students and they all expressed their hope in continued learning with digital pathology to supplement face-to-face lectures. This preliminary study proved that the concept of digital pathology education is a viable venture in medical training particularly, in pathology and medical laboratory. There is need for additional work in terms of inclusion of more areas of coverage in the field laboratory medicine and development of virtual learning content, in order to validate the concept and upscale the local digital slide repository to enrich the use of digital pathology in Kenya and the region and also enhance teaching and learning. Digital pathology coupled with virtual microscopy shall progressively improve in the delivery of pathology and laboratory medicine training and education.

* Corresponding author: Patrick Mutharia. Email: pmutharia@must.ac.ke

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Introduction

Any tissue sample taken in a surgical intervention is sent to the laboratory. The tissue, is placed on a slide and processed depending on the investigations at hand, which is then stained, is examined under a microscope in order to detect pathological structures and changes which then can be treated in a targeted fashion along the clinical pathway.

In digital pathology, the conventional microscope is supplemented with a slide scanner which is linked to a reading station where the image data are assessed. Therefore, the pathologist can still examine and read the physical slide using the conventional way and also read and if necessary store the digital images that are displayed on a monitor for future reference.

There is a global transformation in pathology that has been witnessed as a result of the widespread adoption of whole slide imaging (WSI) in lieu of traditional light microscopes (Pantanowitz L. et al., 2011; Pantanowitz and Parwani 2017). Depicting microscopic pathology characteristics digitally presents new horizons in pathology. Access to digital slides facilitates remote primary diagnostic work, teleconsultation, workload efficiency and balancing, collaborations, central clinical trial review, image analysis, virtual education, and innovative research. The most obvious advantage of digital pathology is the fact that the location of the person reading the slide is no longer linked to the location of the physical tissue sample. Without the need to mail slide and sample, second opinions can already be obtained during initial assessment of the specimen. Furthermore, routine reading of the digital slides can be done from the home or anywhere as long there is steady access to internet. Further, in conjunction with smart analytics like content based image retrieval algorithms (Qi et al., 2014), students could be trained to identify and recognize pathology slides in a dynamic fashion. With the rise in whole slide scanner technology, large numbers of tissue slides are being scanned and represented and archived digitally.

While digital pathology has substantial implications for telepathology, second opinions and education, there are also huge research opportunities with this new type of data. Accessibility to large digital repositories of tissue slides is a huge potential educational resource for medical students and pathology residents. In addition to education of medical students and residents, and clinical adoption, digital pathology has been transformative for computational imaging research. Many universities also do not have active pathology laboratories which are necessary in providing a steady flow of real life cases for medical training and research. Therefore, this project aimed at designing and validating a digital medical laboratory educational platform where learners could ac-

cess the virtual slides from their individual student portals irrespective of where they log in from. With the use of a digital slide scanner, physical slides were scanned and stored in cloud in digital format. The two platforms of both institutions were integrated so that the students' online learning portal was in sync with the Pathology Network's digital repository. Once the integration was successful, the students were able to access a course unit titled "Cell biology," where a topic in cytology and cytological stains was scheduled for teaching. Over the last fifteen years, about sixteen new schools of medicine and health sciences have been opened and approved by the respective regulatory bodies in Kenya. This growth in schools of health sciences has not been accompanied by a commensurate increase in the number of pathologists and laboratory specialists to the teaching Departments of Pathology and medical laboratory leading to a chronic shortage of lecturers in the fields of pathology and laboratory medicine. Pathology and laboratory medicine (PALM) is foundational in the training of doctors and allied medical staff as it creates an understanding of disease processes and prepares students to then understand the rationale of specific treatment. Investing in full-time lecturers, building laboratories, creating physical disease museums and slide repositories for training is expensive, time consuming and rarely provides an exhaustive range of training cases. The world is moving away from these physical tissue repositories and biopsy slides to digital images and whole-slide repositories for teaching pathology laboratory medicine to medical students and for research purposes. While this has become standard of teaching practice in developed countries, it is a rare practice in Africa where it is actually most needed.

Methodology

The project enrolled thirty five full time students of Meru University of Science and Technology who are pursuing Bachelor of Science in Medical Microbiology and had registered for cell biology in that semester when this study was conducted.

The Project commenced in January 2021 for a scheduled period of eight months. However, the activities could only start after delivery and installation of the Grundium Ocus digital slide scanner. The digital slide scanner was then validated by Grundium's technical team. The physical slides were processed and stained using various cytological staining techniques by certified histotechnicians in histology laboratories at the Aroha Cancer Centre. The standard staining procedure was followed. This included; fixation, staining, dehydration, dehydration, clearing and slide mounting. The slides were then scanned using the digital slide scanner while

the client identities of the slides were not disclosed to protect the confidentiality of the clients.

Meru University of Science and Technology uses a learning management system (LMS) that is accessible through the university website and individual student portals. Therefore learners registered for their usual semester units which included cell biology. The Pathology network has an endowed repository of biopsy slides prepared for diagnostic purposes. The two systems were integrated through creation of APIs that provided the interphase.

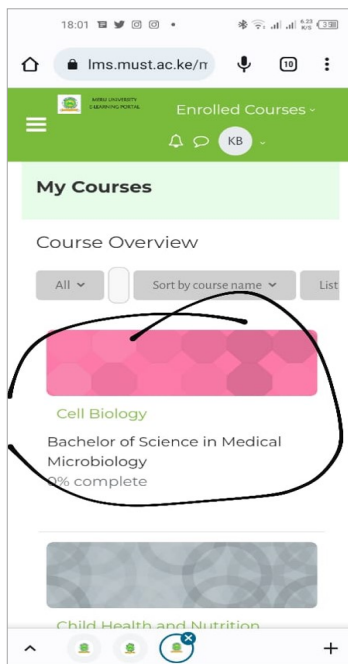


Figure 1: A screenshot of the LMS through which the digital repository is accessed.

The learners confirmed having been able to access the virtual slides in the course of online learning via a link that was available in the learning material for that particular experimental unit of study. The study recruited thirty five students from Meru University of Science and Technology pursuing undergraduate studies in Medical Microbiology. Majority of the students (33 out of 35; 94.3%) indicated that digital pathology enhanced their understanding of the topic of study due to availability of virtual slides with ease and at any time of day. All students (35 out of 35; 100%) felt that digital pathology teaching was beneficial to them as Medical Microbiology students and they all expressed their hope in continued learning with digital pathology to supplement face-to-face lectures.

These virtual slides were not only used for teaching and learning, but they were also used in administering an assessment test in the same topic of study through the integrated virtual system. The durability of the scanned slides which were henceforth in form of digital data was guaranteed to be longer than that of the physical slides while the quality is assured since the images

are not prone to physical damage or breakage, therefore avoiding deterioration. The quality of images from both scanners was found to be satisfactory, although, the clinic scanner was seemingly clearer.

The possibility of providing students with immense diagnostic information was largely observed. According to students, this digital medical laboratory education platform contributed to an improvement in the learning process, as well as their cooperation. Studies done from similar ventures elsewhere have proven that use of digital slides enhanced students' ability to learn (Kumar et al., 2004; Hiedgar et al., 2002).

Due to the enthusiastic nature of students to web-based resources, this platform enhanced a better understanding of the subject matter. This is because all a student required to do was just to log into their individual portal and access a particular lecture via the LMS of which, included the virtual slides. Meaning that as long as a student had access to internet, they are to study or revisit a lecture at their own convenient time.

In terms of teaching, this project established that there is reduced amount of time spent on conventional microscopy procedures and this could actually create time for reviewing specimens together with students.

Conclusion and Recommendation

Digital pathology is capable of improving clinical workflows, reducing the need for storing physical glass slides on site and also reducing the risk of breakage, damage or losing of these slides. This is in addition to the capability to transform research, teaching and diagnostics. Over the years, the number of students enrolled to medical schools in both public and private universities in Kenya has drastically increased. Hence teaching laboratory medicine and pathology via whole slide scanners and digital microscopy is much needed to overcome a number of setbacks such as, increased number of students, shortage of academic staff in field of pathology and difficulties with teaching students in resource limited areas. Therefore, there is imminent need for access to a variety of virtual slides for proper implementation of digital pathology and laboratory medicine. Such large digital repositories of tissue slides is a huge potential in terms of educational resources for medical students.

The scope of this project was majorly restricted to validating the feasibility of teaching and learning using digital images obtained from physical slides using a slides scanner. Hence, it is necessary for this project which has just been validated, to be rolled out on a larger scale in the near future to facilitate realistic realization of successful digital pathology and laboratory medicine. This way, more students in Meru university of Science and Technology that take pathology and laboratory units, will benefit from this wonderful technology.

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