Virtual microscopy and other technologies for teaching histology during Covid-19

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To the Editor, Anatomical Sciences Education:

As in other universities, the Covid-19 pandemic led to the cancellation of face-to-face (F2F) teaching between February and July at the University of South Australia (UniSA). This letter responds to the editorial “Going virtual to support anatomy education: A STOPGAP in the midst of the Covid-19 pandemic” (Evans et al., 2020), published in the special issue of ASE, and outlines the steps taken by the histology team to continue providing synchronous and asynchronous histological microscopy education using a virtual microscopy (VM). The VM slide collection was developed in-house using the NanoZoomer S60 digital whole slide scanner, model C13220-01, (Hamamatsu Photonics, K.K., Hamamatsu City, Japan) and accompanied by NanoZoomer NDP.serve3 software, version U13173-02 (Hamamatsu Photonics, K.K., Hamamatsu City, Japan), that enabled the distribution of whole slide images through UniSA network. As in other similar approaches the Zoom video conferencing platform (Zoom Video Communications, Inc., San Jose, CA) (Pacheco et al., 2020; Srinivasan et al., 2020), Panopto recording software (Panopto Inc., Seattle, WA), and the Moodle learning management system (Moodle Pty Ltd, West Perth WA, Australia) were used to facilitate teaching across remote sites (Pather et al., 2020). Students’ opinions of these teaching arrangements were assessed by way of an anonymous survey.

The laboratory medicine program at the UniSA is designed to prepare students for a career in diagnostic pathology, research, or in other similar laboratories as medical scientists. The program includes advanced subjects, such as histotechnology, transfusion, and clinical chemistry, and graduates are accredited by the Australian Institute of Medical Scientists. Students are typically a diverse cohort of between 30 and 50 students, including local and international students. The second-year Histology course is a core subject that provides the basic building blocks for the advanced clinical courses taken in the third and fourth year of Laboratory Medicine. This course has historically been considered highly challenging by undergraduate students, which is why, in 2018, Histology course academics committed to improving student learning outcomes with the use of a VM; importantly, professional and academic fields have also been moving in this direction (Saco et al., 2016; Vainer et al., 2017; Lee et al., 2018; Wong et al., 2018).
The teaching slide set was scanned with a NanoZoomer digital slide scanner and uploaded to the UniSA hosted NDP.serve3 server site. Sections of tissue could be viewed online through digital pathology network in the same way that they can be viewed with a conventional microscope. This allowed students to access the necessary learning materials outside limited microscopy practical sessions to aid in revision and to help achieve a deeper understanding of histological practice and theory.

Thirty-one second-year histology student students were involved in the education setting. The Histology course ran for 13 weeks from March to July. Typically, students have two hours of live lectures and three hours of practical microscopy work each week. Before the Covid-19 pandemic, the Histology course was taught entirely F2F, and the VM was used as an adjunct to the teaching. However, in 2020, all F2F lectures and practical sessions were canceled in the third week of the study period as a direct result of the pandemic. By this point, the students had already completed three out of 13 microscopy practical sessions. Assessments included two multiple-choice and short-answer tests, a practical laboratory booklet to be completed during the practical sessions and handed in at the end of the study period, a final written examination and a F2F practical microscopy examination of ten unidentified tissue sections. The tests and the final written examination were migrated to the Moodle site and were taken by students as a timed, open book examination at home. The F2F practical microscopy examination went ahead as planned due to the lifting of virus-control restrictions.

Live lectures were immediately moved to online recorded lectures, and all lectures were new recordings. Lectures featured a PowerPoint slide lecture (Microsoft Corp., Redmond, WA) and were recorded using Panopto recording software. Lectures were uploaded to the Moodle site weekly to be viewed asynchronously. Course coordinators were cognizant of the need to avoid poor-quality learning experiences by only providing asynchronous lectures (Evans et al., 2020); therefore, a learner-centered curriculum was designed.

The academics focused on active learning and sought to create an environment that balanced student independence with teacher guidance. Active learning, particularly in the context of e-learning, involves engaging students through formal and informal interactions while increasing the
complexity of the subject matter (Ellis and Goodyear, 2019). Research has shown that an active learning approach to histology teaching that incorporates VM yields beneficial outcomes on student success (Bloodgood, 2012; Tian et al., 2014).

Each topic included a lecture that set out the core knowledge that students were required to learn; a short formative quiz, which was not assessed and could be attempted multiple times; and a short two- to seven-minute video summarizing the main points. The Instagram page (Facebook Inc, Menlo Park, CA) was created to add an informal aspect to the students’ learning to enable students to digest small amounts of learning content and interact with academics and peers in an informal environment (Caruso, 2020). Social media can provide an excellent extrinsic motivator to participate in informal learning by facilitating short bursts of learning. Like others, we found short, self-directed learning modules for each course topic were essential for engaging and motivating learners (Carliner, 2013). Informal communities offer individuals the freedom to express their ideas without restrictions (Ala-Mutka et al., 2009). Students are increasingly connected on social media platforms; therefore, such platforms are an ideal place for establishing informal learning situations. Indeed, studies have shown that social media platforms like Facebook and Instagram, when used for teaching, can provide access to relevant, curated, and succinct learning materials (Cooke, 2017).

Each topic was finalized with a synchronous virtual microscopy laboratory session that examined sections of the tissue histology covered in the topic content. Students could join the Zoom video conferencing platform session remotely through any device. During the sessions, the academics would share their screen when viewing sections at various magnifications and would describe the histology observed. During the virtual lesson, the teacher asked questions to provoke discussion, and the students could respond and interact both orally and through the Zoom “chat” function. The share screen function enabled the teacher the talk through the histology using the virtual sections and toggle back to the lecture material to reinforce the learning. The sessions were recorded using Panopto recording software; both the computer audio and main screen were recorded. The sessions were subsequently made available to students on the Moodle site for their review within 24 hours. All posts to the @patholife Instagram page reflected the week’s Zoom discussions to reinforce the content further (Caruso, 2020). Students were required to complete a comprehensive practical
booklet of questions based on the VM slides, which included histological drawings and annotations of sections. The booklets were assessed at the end of the study period.

A survey was added to the course site to evaluate students’ perceptions of the value of the Zoom laboratory session with ethics approval from UniSA’s Human Research Ethics Committee CRICOS provider number 00121B (Application ID: 203615). Of the respondents (n = 14), students rated the effectiveness of teaching via Zoom laboratory sessions as 4.92 ± 0.3 out of 5 and gave an average score of 4.78 ±0.42 for consolidation of their understanding of the lecture content. Students highlighted specific benefits as self-paced learning and improved tissue recognition due to better access to slides (see Supplemental Material File).

The assessment quiz and examination results were slightly better in 2020 than in the previous year, where the VM was only used as an adjunct to teaching. However, the assessment pieces were online and open book in 2020 and were F2F and closed book in 2019, which could account for the difference in the results. The F2F practical examination was delivered the same way in 2020 and 2019 because restrictions had eased enough to allow for F2F practical sessions at the time of the practical examination. Students performed better in 2020 (84.2% ±28.0, mean ± SD, n = 30) compared with 2019 (69.0% ±19, mean ±SD, n = 46) in microscopical identification of histological sections. This suggests that the structure of the virtual Histology course was as effective, if not better, than F2F histology teaching, a result seen across other similar studies (Harris et al., 2001; Barbeau et al., 2013; Lee et al., 2020).

The stakeholders involved with the course, including students, academics, and the university itself, were happy with the success of the switch from F2F learning to wholly online teaching and learning. The academics showed that a well-designed course that adopts a learner-centric approach can overcome the perceived limitations of online teaching. The primary difficulties involved virtually teaching a kinesthetic skill, such as microscopy work and the student-teacher communication barriers previously described in virtual anatomy teaching (Attardi 2016). The first was remedied by scaffolding the complexity of information, providing students with ample opportunities to practice their learning, delivering multiple synchronous and asynchronous learning situations that were both formative and summative, and the second, by providing platforms and safe spaces to enable the
students to feel a sense of belonging with their cohort and teacher. We have used Instagram, but similar studies have used platforms such as WhatsApp to achieve the same goal (Pacheco et al., 2020). Studies have shown that students feel a greater sense of belonging with a program when engaged in a social network related to that program. A sense of belonging has been shown to positively correlate with academic persistence and knowledge construction between students who instinctively form connections in formal environments and when social media is used, form connections with unrelated students (Thomas 2000). The synchronous virtual laboratory sessions and the @patholife Instagram page (Caruso, 2020) helped foster a sense of belonging among the cohort and enabled students to engage in active learning in a formal academic-to-student scenario and an informal peer-to-peer scenario.

This endeavor proved rewarding for both students and academics. However, the teachers agreed with other studies, that anatomical and histological sciences should not be delivered exclusively online (Evans et al., 2020), particularly programs that are designed to equip students with work-ready skills at graduation, such as the Laboratory Medicine Program (Pacheco et al., 2020). In Australia, most anatomical pathology work is performed using a microscope, which is, therefore, a vital skill for Laboratory Medicine students, development of skills F2F in the laboratory is the gold standard for teaching (Franchi 2020). Further, the ability to establish a “teacher presence” was more challenging with online-only learning, and a single Zoom session per week was found to be insufficient to form secure connections with students. Online delivery of course content was costly in both time and personal connection, and an extraordinary commitment of time and money would be required for the complete online delivery of the Histology course as a replacement for F2F learning.

Employing the appropriate Web 2.0 tools can help students take ownership of their own learning, synthesize learning, and foster a deeper engagement with the subject matter. Digital technologies facilitate exciting new ways for academics and learners to interact meaningfully. As suggested by Franchi (2020) we have developed a purposely designed course with a range of invaluable learning artifacts and unique teaching experiences in response to an extraordinary situation, and the success of the Histology course during this challenging time will enhance the course in the coming years.
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LITERATURE CITED

Ala-Mutka K, Punie Y, Ferrari A. 2009. Review of learning in online networks and communities. In: Cress U, Dimitrova V, Specht M (Editors). Learning in the Synergy of Multiple Disciplines. 4th European Conference on Technology Enhanced Learning, EC-TEL 2009, Nice, France, September/October 2009, Proceedings. 1st Ed. Heidelberg, Germany: Springer-Verlag. p. 350–364.

Attardi SM, Choi S, Barnett J, Rogers KA. 2016. Mixed methods student evaluation of an online systemic human anatomy course with laboratory. Anat Sci Educ 9:272–285.

Barbeau ML, Johnson M, Gibson C, Rogers KA. 2013. The development and assessment of an online microscopic anatomy laboratory course. Anat Sci Educ 6:246–256.

Bloodgood RA. 2012. Active learning: A small group histology laboratory exercise in a whole class setting utilizing virtual slides and peer education. Anat Sci Educ 5:367–373.

Carliner S. 2013. How have concepts of informal learning developed over time? Perform Improv 52:5–11.

Caruso MC. 2020. Instagram @patholife. URL: https://www.instagram.com/patholife/ [accessed 20 November 2020].

Cooke S. 2017. Social teaching: Student perspectives on the inclusion of social media in higher education. Educ Inform Tech 32:255–269.

Ellis RA, Goodyear P (Editors). 2019. The Education Ecology of Universities: Integrating Learning, Strategy and the Academy. 1st Ed. Abingdon, Oxon, UK: Routledge. p. 264.
Evans DJ, Bay BH, Wilson TD, Smith CF, Lachman N, Pawlina W. 2020. Going virtual to support anatomy education: A STOPGAP in the midst of the Covid-19 pandemic. Anat Sci Educ 13:279–283.

Franchi. 2020. The impact of the Covid-19 pandemic on current anatomy education and future careers: A student’s perspective. Anat Sci Educ 13:312–315.

Harris T, Leaven T, Heidger P, Kreiter C, Duncan J, Dick F. 2001. Comparison of a virtual microscope laboratory to a regular microscope laboratory for teaching histology. Anat Rec 265:10–14.

Lee BC, Hsieh ST, Chang YL, Tseng FY, Lin YJ, Chen YL, Wang SH, Chang YF, Ho YL, Ni YH, Chang SC. 2020. A web-based virtual microscopy platform for improving academic performance in histology and pathology laboratory courses: A pilot study. Anat Sci Educ 13:743–758.

Pacheco LF, Noll M, Mendonça CR. 2020. Challenges in teaching human anatomy to students with intellectual disabilities during the Covid-19 pandemic. Anat Sci Educ 13:556–557.

Pather N, Blyth P, Chapman JA, Dayal MR, Flack NA, Fogg QA, Green RA, Hulme AK, Johnson IP, Meyer AJ, Morley JW, Shortland PJ, Štrkalj G, Štrkalj M, Valter K, Webb AL, Woodley SJ, Lazarus MD. 2020. Forced disruption of anatomy education in Australia and New Zealand: An acute response to the Covid-19 pandemic. Anat Sci Educ 13:284–300.

Saco A, Bombi, JA, Garcia A, Ramírez J, Ordi J. 2016. Current status of whole-slide imaging in education. Pathobiology 83:79–88.

Srinivasan DK. 2020. Medical students’ perceptions and an anatomy teacher’s personal experience using an e-learning platform for tutorials during the Covid-19 crisis. Anat Sci Educ 13:318–319.
Tian Y, Xiao W, Li C, Liu Y, Qin M, Wu Y, Xiao L, Li H. 2014. Virtual microscopy system at Chinese medical university: An assisted teaching platform for promoting active learning and problem-solving skills. BMC Med Educ 14:74.

Thomas SL. 2000. Ties that bind: A social network approach to understanding student integration and persistence. J High Educ 71:591–615.

Vainer B, Mortensen NW, Poulsen SS, Sørensen AH, Olsen J, Saxild HH, Johansen FF. 2017. Microscopy in the medical curriculum digital: Experiences from The Faculty of Health and Medical Sciences at University of Copenhagen. J Pathol Inform 8:11.

Wong M, Frye J, Kim S, Marchevsky AM. 2018. The use of screencasts with embedded whole-slide scans and hyperlinks to teach anatomic pathology in a supervised digital environment. J Pathol Inform 9:39.