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Parasitology Education Before and After the COVID-19 Pandemic

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The COVID-19 pandemic has disrupted parasitology curricula worldwide, which is expected to lead to the reshaping of parasitology education. Here, we share our experiences of remote teaching and learning of veterinary parasitology and discuss opportunities offered by remote teaching during COVID-19 lockdowns, enabling the development of interactive online parasitology courses.

Parasitology Learning and Teaching before the COVID-19 Pandemic

Since the beginning of the 21st century, several face-to-face and blended (i.e., face-to-face and online) learning practices, including the disciplinary-based and problem-oriented approaches, have been used to teach the various disciplines of parasitology worldwide [1]. For example, various learning theories for online and/or blended parasitology education, including 'community of inquiry' [2], 'connectivism' [3] and 'online collaborative learning' [4], have been used. Recently, the 'blending with pedagogical purpose model' [5] has most commonly been used for teaching and learning in parasitology [1] and other disciplines [6] where students are the learning community and multiple technologies (e.g., learning management systems) and multimedia are utilised to (i) scaffold and deliver the content of subjects/courses; (ii) promote reflective blog journals, with collaboration and peer-to-peer learning among students; and (iii) evaluate student learning. However, the social presence in a learning setting is often achieved by face-to-face teaching and interactions among students, which are key components of a learning environment. In the last two decades, these blended, student-centred learning practices [7], using adaptable digital technologies [8,9], have become useful tools for effective and engaging parasitology teaching and learning.

The COVID-19 pandemic has challenged the existing teaching and learning practices from primary schools through to tertiary institutions in almost every country of the world [10]. Rapid conversion from face-to-face or blended learning to completely online or distance learning was essential, but potentially problematic, as an effective online learning programme is complex, resource-intensive and time-consuming [11]. Here, we provide a perspective from our experiences in the Melbourne Veterinary School as we rapidly extemporised to provide solutions for the online delivery of large and group-based sessions for veterinary parasitology. Our goal is to share our experiences in the midst of the COVID-19 pandemic which has brought about great uncertainty and challenges in almost every walk of life. The rapid shift seen across the tertiary education system might be the beginning of a new era in course delivery. The adoption and/or modification of teaching and learning practices tested (out of necessity) during the COVID-19 lockdown may guide or influence the redesign of parasitology curricula.

Transitioning to 'Absolute Online' Parasitology Learning and Teaching

On Tuesday 17 March 2020, the Melbourne Veterinary School suspended all face-to-face teaching and we, as educators, were given 3 days to prepare for the online delivery of lectures and practical parasitology classes scheduled for the following week. Our parasitology team at the University of Melbourne has extensive experience in teaching parasitology to animal science and veterinary students. Prior to the COVID-19 pandemic, we adopted new approaches to enhance learning outcomes utilising a combination of conventional face-to-face teaching and digital technologies [9]. Through reflective practice, and considering the original intended learning outcomes (ILOs), we rapidly adapted the face-to-face lectures and practical classes in parasitology to online modules for Doctor of Veterinary Medicine students (second- and third-year levels within a 4-year degree, 130 students/cohort) and Bachelor of Agriculture students (third/final year level, 80 students). In support, the University offered various professional development courses through the Department of Learning Environments[i] to staff and students to aid with the transition to remote/online teaching. Based on our experiences of online teaching and learning in the field of veterinary parasitology, we have proposed a toolkit (Box 1) for parasitology educators; our teaching module received appreciation from students (see Table S1 in the supplemental information online) and academic peers alike.

For timely lecture delivery, we uploaded prerecorded lectures on a learning management system (e.g., Canvas[ii]) to allow student self-directed, independent learning and to avoid possible network access issues during live streaming of lectures. Subsequently, we held weekly flipped classroom [9] sessions (i.e., live question and answer (Q&A)) via Zoom[iii] and used polls[iv] to provide opportunities for cognitive, social, and teaching presence for the online learning experience of students, as per the learning theory of 'community of inquiry' [2]. For practical classes, we used a number of approaches and utilised predeveloped resources available online (Box S1), circumventing the difficulties associated with preparing, at short notice, a semester's worth of high-quality material, especially videos using the Loom application[v].

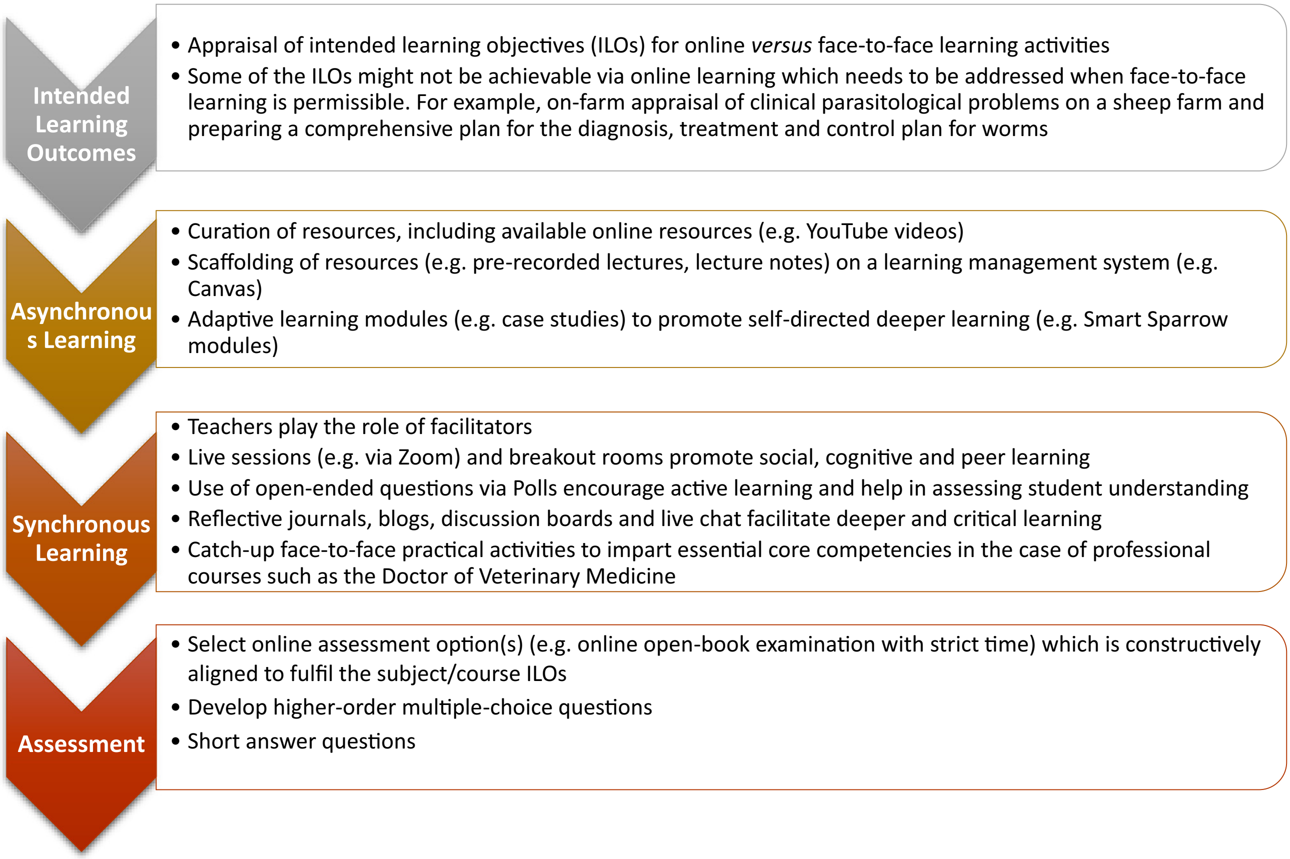
Box 1. Tips for Online Teaching and Learning of Parasitology

b]1. Set reasonable expectations as per the intended learning outcomes (ILOs) of the subject/course in an online learning environment.
2. Make a scaffold of various learning modules on a learning management system which is easy to follow.
3. Prerecord lectures and show your face – as students appreciate it.
4. Keep videos short and test slides before making them available online.
5. Use existing 'active' resources and specify the parts that need to be viewed.
6. Provide interactive group activities (e.g., online quizzes, polls, discussion boards, subject dedicated Facebook page, etc.) which support peer learning and collaboration.
7. Communicate clear instructions and expectations about the assessment.
8. Emotional openness is a great instructional strategy, so do not hide your feelings and use 'icebreakers' during teaching and learning activities. For example, ask at the beginning of a lesson 'What is a new skill/interest you have undertaken during isolation?'.
9. Use virtual office hours, using platforms like Zoom, to interact and provide social support to students. This can be a great way to collect student feedback on your online teaching and identify any issues which need immediate addressing.
10. Once you find a teaching style working for you, feel free to repeat it each week until you are back in your classroom!

Our typical veterinary parasitology practical class involves the identification of a group of parasites, assorted hands-on techniques to isolate and identify parasites in various organs of a range of hosts, and problem-based clinical scenarios for veterinarians. We developed the 3 h face-to-face practical classes into online modules using various asynchronous and synchronous teaching approaches to encourage deep learning, while promoting student engagement, the interaction between students and teachers, and metaconnective pedagogy [12]. For each online practical class, we developed a PowerPoint presentation (Box S1) which outlined all components of the practical and provided links to external online available resources, and these slides were uploaded on Canvas 1 week prior to the practical class. The online practical contained an introduction to the class via a 15–20 min live interactive session using Zoom, followed by multiple independent and collaborative sessions for students via breakout rooms in Zoom, ending with a 30 min summary via a live Zoom session using polls. The Zoom breakout room feature allowed student collaboration and lecturers to interact within smaller groups of students (ten per group). Students were also provided with the opportunity to ask questions directly via Zoom unmute, a Zoom chat (typed) as well as through an online discussion page in Canvas. In addition to recorded lectures, the entire practical class was recorded and made available to students via Canvas for later viewing, and for students unable to attend the session, or those that were in another state or country. This method of online delivery of our veterinary parasitology subject received very positive feedback from students (Table S1). Additionally, we tried to mimic virtual microscopy sessions by preparing high-quality videos, high-resolution scanning of slides, or photography of gross specimens (Box S1) and presenting them via several user-friendly commercially available platforms[vi]. The BEST network platform, in particular, is highly interactive as it not only allows a virtual microscopic experience but also permits annotation which is an invaluable tool for both students and teachers. In addition to positive student feedback, the average exam scores for prepandemic and postpandemic cohorts were comparable, indicating that the modified methods of content delivery were effective. Strategically targeted questions using a flipped classroom approach [9] were also posed to students during the online Q&A sessions/practicals (using a polling application) which allowed live gauging of the level of student understanding. Some of the ILOs for practical classes could not be achieved via online learning which will be addressed when face-to-face learning becomes permissible.

Will Learning Experiences and Reflective Practices Developed during the COVID-19 Pandemic Help Shape Aspects of Future Parasitology Curricula?

Recently, we provided a critical overview of some of the current trends in the use of digital technologies in higher education and presented a case for the use of these technologies in the blended learning of parasitology [9]. This year, the COVID-19 pandemic has tested our flexibility and willingness as educators and students to change and has forced us to teach and learn parasitology remotely using digital technologies [9]. There are multiple learning theories but to date, no single online education theory has emerged that can be used in online learning and teaching of parasitology. The online parasitology teaching and learning approach described here is based on the 'blending with pedagogical purpose model' [5,6], and could be useful for online education of parasitology into the future (Figure 1). This approach utilises both asynchronous and synchronous remote learning methods, where the former allows independent learning online or offline, and the latter involves the real-time (e.g., via Zoom) teaching and learning encounters. Findings of previous studies [13,14] have shown that synchronous learning is more effective than asynchronous learning for students that struggle with higher-level cognitive demands in academic settings. For asynchronous learning, resources require curation for online/offline learning by providing a learning roadmap to support the subject ILOs and to prepare students for the interactive and intensive online synchronous learning sessions (Figure 1). Additionally, real-time feedback and commentary on students' underlying thought processes in dealing with 'real-world' veterinary parasitology problems can be provided using adaptive learning activities [8]. It should be noted that



Trends in Parasitology

Figure 1. Model for Online Learning of Parasitology. Flow diagram of combined asynchronous and synchronous remote learning methods, where the former allows independent learning online or offline, and the latter involves real-time teaching and learning encounters. The learning methods are preceded by setting clear intended learning outcomes (ILOs) and conclude by selecting and completing online assessment options that align with the subject/course ILOs.

online active learning sessions aim to trigger and encourage discussion, where the teacher acts as a facilitator rather than an instructor, thereby creating a social and metacognitive atmosphere for deeper student engagement, which happens in the classroom during face-to-face learning. We found that real-time student polling using open-ended questions guided the learning process, allowing us, as teachers, to gauge students' knowledge and understanding and to modify the direction of a lesson as/if required. Zoom chat and discussion boards were also useful because their use promoted peer learning, while the teacher was moderating the sessions. In a classroom setting, the paper-based assessment is the most commonly used examination method. However, for remote learning of parasitology, we adapted our assessment to online, open-book examination, with strict time limits; this experience showed that a combination of multiple-choice[vii] and short-answer questions were useful to test higher-level learning with minimum chance of student collusion during exams.

A limitation of the online learning method we adopted is that it is reliant upon computer network connection. For students who may have potentially been disadvantaged by access issues, we provided all resources (lecture and practical recordings, lecture slides and study notes) in a central repository (Canvas). As an additional measure to ensure that remote learning was inclusive for all students, materials covered in online Q&A sessions/flipped classroom/practicals were provided to students several days in advance to allow sufficient preparation time, familiarity with the content, and discussion amongst themselves. Despite these measures, full online delivery of a subject may lead to students missing out on some interactive aspects of learning which would normally occur during practical classes. Our approach, although not providing a learning experience identical to face-to-face teaching approaches pre-COVID-19, provided a similar experience during the extraordinary circumstances (lockdown) imposed by the pandemic.

In 2020, the COVID-19 pandemic forced us to rapidly improvise solutions to maintain and attempt to enhance student experiences and learning outcomes by evaluating asynchronous and synchronous learning practices for remote teaching. While our experiences have been positive, we believe that future studies will be required to objectively assess whether the new methods will continue to be useful/ sustained when we return to face-to-face learning. We believe that there are many opportunities to challenge conventional practices of parasitology teaching and learning which have remained relatively static for years. There are now great opportunities for us to assess innovative learning practices, with the advent of artificial intelligence, automation, machine learning, and virtual reality in the near future. We may ask ourselves which reflective practices of remote learning can help us to enhance students' engagement, and can metaconnective pedagogy and collaboration be provided in an online learning context?

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Supplemental Information

Supplemental information associated with this article can be found online at https://doi.org/10.1016/j.pt.2020.10.009.

Resources

[i]https://le.unimelb.edu.au
[ii]www.instructure.com/canvas/en-au
[iii]www.zoom.us
[iv]www.polleverywhere.com
[v]www.loom.com/loginh
[vi]www.best.edu.au/slice/
[vii]https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0010/3430648/multiple-choice-questions_final.pdf

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Spotlight

Booming Omics in *Schistosoma*

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Efforts to eliminate schistosomiasis are hindered by incomplete efficacy of the only FDA-approved antischistosomal drug, praziquantel. By using postgenomic technologies, Wendt *et al*. and Wang *et al*. deciphered the function of several genes required for worm survival and pathogenesis, which opens the way for the development of innovative parasite-targeted therapies.

Schistosomiasis — also known as bilharziasis — is one of the most devastating of the world's neglected tropical diseases that is responsible for considerable human morbidity. The etiological agents, schistosomes, are dioecious flatworms that reside permanently *in copula* within the host's blood vessels. While blood feeding, the females lay eggs of which the majority become encysted in surrounding host tissues and organs (especially the liver), causing pathology [1]. Despite increased efforts to eradicate schistosomiasis over the past five decades, more than 200 000 people still die each year from schistosome-associated complications [2]. This apparent failure to control disease transmission is, in part, due to the incomplete parasiticidal efficacy of praziquantel, which is ineffective on immature worms and does not prevent reinfection or the emergence of drug-resistant parasites. Accordingly, in the recently published roadmap, aiming at eliminating schistosomiasis by 2030, the World Health Organization (WHO) highlights that new antischistosomal treatments are urgently needed [3].

Hitherto, the development of innovative therapies has been hampered by the paucity of molecular and genetic tools for exploring schistosome biology. In their two recent enlightening articles, Wang *et al.* [4] and Wendt *et al*. [5] provide new insights into the functional biology of schistosomes that will undoubtedly unleash the discovery of new potential drug targets.