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Forced Disruption of Anatomy Education in Australia and New Zealand: An Acute Response to the Covid-19 Pandemic

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Australian and New Zealand universities commenced a new academic year in February/March 2020 largely with "business as usual." The subsequent Covid-19 pandemic imposed unexpected disruptions to anatomical educational practice. Rapid change occurred due to government-imposed physical distancing regulations from March 2020 that increasingly restricted anatomy laboratory teaching practices. Anatomy educators in both these countries were mobilized to adjust their teaching approaches. This study on anatomy education disruption at pandemic onset within Australia and New Zealand adopts a social constructivist lens. The research question was "What are the perceived disruptions and changes made to anatomy education in Australia and New Zealand during the initial period of the Covid-19 pandemic, as reflected on by anatomy educators?." Thematic analysis to elucidate "the what and why" of anatomy education was applied to these reflections. About 18 anatomy academics from ten institutions participated in this exercise. The analysis revealed loss of integrated "hands-on" experiences, and impacts on workload, traditional roles, students, pedagogy, and anatomists' personal educational philosophies. The key opportunities recognized for anatomy education included: enabling synchronous teaching across remote

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sites, expanding offerings into the remote learning space, and embracing new pedagogies. In managing anatomy education's transition in response to the pandemic, six critical elements were identified: community care, clear communications, clarified expectations, constructive alignment, community of practice, ability to compromise, and adapt and continuity planning. There is no doubt that anatomy education has stepped into a yet unknown future in the island countries of Australia and New Zealand. Anat Sci Educ 13: 284–297.

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INTRODUCTION

Universities across Australia and New Zealand commenced the new academic year in February and March 2020. For most institutions, it was largely business as usual. Few realized the extent of disruption and the pace of change that the unfolding Covid-19 global pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), would impose upon all higher education (Evans et al., 2020).

The first Covid-19 cases were reported in Australia and New Zealand at the end of January and February 2020 (WHO, 2020), respectively, and were related to people travelling for tourism, work or study. Even though most universities at first adopted a "watch and wait" approach, it became quickly evident that a higher education sector interruption was imminent (Truu, 2020). The extent of this disruption was evidenced by an almost immediate restriction on business travel for many university staff, initially to China (Perpitch, 2020); and a resulting large number of Australian and New Zealand anatomy academics cancelled plans to attend international meetings and conferences. As the governments acted to prevent the pandemic spread, some university leaders drew on the experiences and expertise of their faculty, and acted quickly to source equipment, manage logistics, and provide in-time assistance to support the university's continued operations.

In the background, core university business appeared to continue as usual. Managements' "watch and wait" approach was perceived to be passive, causing some staff and student distress with the apparent lack of decisive action. University leaders, however, were carefully monitoring the situation to delay an inevitable transition to remote learning for as long as possible. At the beginning of March, the signs of higher educations' imminent disruption presented as Australia and New Zealand entered the "protect" phase of pandemic management learnt from past corona virus experiences (Collignon, 2011; de Wit et al., 2016). By mid-March, the responsibility fell on academic staff to actively repurpose and redeploy resources, upskill their digital competencies, and develop new material to transition traditionally face-to-face (F2F) and blended programs to a remote learning and/or online education delivery mode (Johnston, 2020). Like in many countries, Australia and New Zealand included, technology-integrated learning has been embedded in medicine and allied health programs for some time (Harden, 2006). Anatomists in this region have been actively involved in the development of digital resources and in curriculum reform (Green and Whitburn, 2016; Colibaba et al., 2017; Otton et al., 2017; Green et al., 2018; Birbara et al., 2019; Ho et al., 2019; Birbara et al., 2020; O'Rourke et al., 2020). Anatomy education, however, has never before been delivered solely online or remotely for medicine and allied health programs in these countries.

The Tertiary Education Quality and Standards Agency (TEQSA), which is the mandatory independent national quality assurance and regulatory body for higher education in Australia (Supporting Information Table 1), acted quickly and decisively, enabling rapid educational transformation by announcing to the sector a broad reduction of the regulatory burden for universities managing Covid-19 pandemic challenges (Saunders, 2020). This deregulation provided universities with approval to effect changes to delivery modes, as well as to provide remote learning to students who were offshore. This last aspect is critical to higher education in Australia which serves a large international student body (Davies and Karp, 2020). In 2018, 398,593 students enrolled with Australian higher education providers were on student visas and comprised a third of the student population (Ferguson and Sherrell, 2019). During March 2020, an overwhelming number of international students were forced to return to their homeland as the pandemic spread. The TEQSA caveat, however, was that: "Providers should assure themselves that such arrangements [changes to program delivery] maintain assessment and quality standards and are appropriately documented" (Saunders, 2020). Most institutions were, thus able to rapidly initiate a business continuity plan enabling students to continue the academic year, if they chose.

In quick succession over the last 2 weeks of March 2020, medicine and science faculties of most universities in Australia and New Zealand converted to online and/or remote delivery as university staff moved into a new paradigm of "working from home" (WFH) arrangements. Defined by Simonson et al. (2011), remote/distance learning refers to institution-based, formal learning, where the learner and instructor are physically separated, and where interactive telecommunications systems are used to connect learners, resources, and instructors. In part, the business continuity plan (especially for medicine faculties) in Australia was driven by pragmatism to ensure a functioning health care system in 2021, which relies heavily on graduating medical students entering the system as junior doctors (interns) each year.

For the discipline of anatomy, this decision has potentially fundamental consequences. The governments mandated Covid-19 response resulted in restricted movement and physical distancing requirements. The regulations initially constrained anatomy laboratory access, but quickly progressed to a prohibition of students' laboratory access entirely as WFH and remote learning arrangements became the new normal. The initial stage of this transition may be particularly challenging to those in the anatomy discipline as many conventional anatomy education pedagogies rely

on "hands-on" practical experience; it is through these small groups that many anatomy educators identify and respond to students' learning needs especially those at-risk of underperforming (Kumar Ghosh and Kumar, 2019). Furthermore, delivering anatomy education solely online or at a distance, if only for a short period, challenges the long-held educational philosophy of many anatomy educators (Pather, 2015). Additionally, for those who strive to frame their anatomy programs through a lens of ethics and humanism (Štrkalj and Pather, 2017; Evans et al., 2018; Hildebrandt, 2019), there is a need to work harder to connect students to these paradigms when educating solely within the digital realm, and in the absence of a once-living person (Stephens et al., 2019; Kumar Ghosh and Kumar, 2019). Notwithstanding these issues, the remarkable mobilization, commitment, speed, and agility of the Australian and New Zealand anatomy community, including academic and support/technical staff, presents the beginning of a historic bridge into an unknown future. The continuity of anatomy education during the Covid-19 pandemic in Australia and New Zealand is not "business as usual" and is not likely to return to the pre-pandemic approaches again, given the extent of the present changes. This study, therefore, aimed at documenting the shared experiences of anatomy educators in changing their teaching practice during the early period of the Covid-19 pandemic within Australian and New Zealand higher education.

MATERIALS AND METHODS

Participant Recruitment

Participants were voluntarily recruited via an email invitation to anatomists serving in leadership roles in the Australia and New Zealand Association of Clinical Anatomists (ANZACA), with snowballing recruitment following. The resultant participant group, and co-authors, included 18 academic anatomists representing ten institutions across these two island countries. In Australia, this group represented four of the Australian States and Territories, and five of the "Group of Eight" universities (leading eight Australian research-intensive universities) (Table 1). In New Zealand, the participants represented one of the (only) two New Zealand universities that teach anatomy. All participants taught anatomy (including neuroanatomy), histology and/or embryology to a variety of student cohorts including science, biomedical science, allied health, and undergraduate and graduate medicine, as well as junior (i.e., resident) and postgraduate (attendings) doctors using multiple approaches before the pandemic (Supporting Information Table 2).

Research Question and Methodology

The research question was "*What are the perceived disruptions and changes made to anatomy education in Australia and New Zealand during the initial period of the Covid-19 pandemic, as reflected on by anatomy educators?*." All participants were asked to reflect on the experience of delivering anatomy education from the start of the academic year through to the end of March 2020. This descriptive qualitative account of anatomy education disruption focusses on the early stages of the pandemic within Australia and New Zealand, with the methodology of adopting a social constructivist lens, wherein the truth is negotiated by those experiencing it (Rees et al., 2020).

Thematic analysis to elucidate "the what and why" of anatomy education was applied to these reflections, as outlined by Nowell et al. (2017). The names of institutions were de-identified during thematic analysis. Six phases of coding were undertaken with Phase 1 ("data familiarization"), Phase 2 ("initial coding"), and Phase 3 ("theme searching"), carried out by M.D.L. Phases 4 and 5 ("theme review" and "naming themes") were carried out separately by two authors (M.D.L., and N.P.). Phase 6 ("findings report production") was initially drafted by M.D.L., with N.P. providing feedback, debating, and discussing interpretation discrepancies. While these stages appear linear, each progressive stage was iterative, and thus previous stages were addressed where needed during Phase 6. All analyses were performed in Microsoft Word (Microsoft Corp., Redmond, WA) as higher order complex coding was not undertaken due to the research question.

This approach to thematic analysis included a team-based reflexive exercise (Barry et al., 1999) by those undertaking the analysis (M.D.L., and N.P.). Both authors have extensive experience in qualitative research and value grounded theory in answering the research question, but they differ slightly in world views. While one allows the research question to dictate the methods, the other struggles with the idea of quantitative analysis ever being objective, due to inherent complexities of the natural world. Both thought the opportunity to reflect, and learn from others' reflections, was a valuable opportunity. The fears expressed in undertaking this study included concern for peer wellness and rapidity of data analysis—but overall, both authors thought the study merits outweighed the risks.

Ethical Approval

This study was approved by the Monash Human Ethics Review Board Research Ethics Committee (MUHREC #24292).

RESULTS

Continuing Anatomy Education During the Pandemic

In Australia and New Zealand, F2F laboratory practical sessions are central to anatomy teaching (Table 1). Participating anatomy educators' reflections outlined the progressively increasing restrictions placed on F2F teaching (e.g., increased physical distancing, cancellation of practical sessions, or complete campus lockdown). These restrictions were coupled with an almost consistent university message: The universities in Australia and New Zealand are "open for business" with a status of "business as usual." This disconnect between university messaging and imposed social constraints appeared to contribute to at least some of the shared academic anatomists' challenges outlined below. One New Zealand academic summed up the higher education pandemic setting concisely in stating: "*There is no doubt from our perspective that the world is suddenly a different place.*"

In continuing anatomy education during the initial pandemic period, nearly all universities appeared to employ a mix of synchronous and asynchronous (Chen et al., 2005; Watts, 2016) online activities (Table 1), with some institutions having used evidence-based online activities to deliver the curriculum prior to the pandemic. Notably, nearly all chose at least some synchronism to mitigate the loss of the practical "hands-on"

Table 1.

Anatomy Education Approaches Engaged During Transition to Pandemic Response Teaching

University (State, Country)	Human body donor program status	Lecture delivery	Practical sessions delivery		
			Online pandemic delivery	Planned F2F post-pandemic intensive	Active online learning
Australian National University[a] (Australian Capital Territory, AUS)	**Suspended** during the pandemic	**Prerecorded** 2019; concept videos	**Asynchronous** and **synchronous** with multimedia and formative assessment resources	**Yes**, for medical students	**Asynchronous** problem-solving activities; **Synchronous** live streamed small group sessions
La Trobe University (Victoria, AUS)	**Open**	**Prerecorded** videos created over last 3 years; **live-streamed** sessions with breakout rooms	**Asynchronous** (practical videos) and **synchronous** interactive small groups sessions	**No**	**Asynchronous** discussion boards; **Synchronous** live streamed interactive sessions
Macquarie University (New South Wales, AUS)	**Suspended** during the pandemic	**Prerecorded** with a focus on mini videos of core material	**Asynchronous** and **synchronous** activities	**Yes**, for medical students	**Asynchronous** problem-solving activities for neuroanatomy
Monash University[a] (Victoria, AUS)	N/A	**Prerecorded**; **live streamed**	**Synchronous** small groups activities	**Yes**, for medical students	**Asynchronous** discussion boards
University of Otago (Dunedin, NZ)	**Suspended** during the pandemic	**Prerecorded** (2019) where possible, new recordings	**Asynchronous** with multimedia and formative assessment resources	**No**	**Asynchronous** problem-solving cases with clinical relevance (where appropriate), tutorials
University of Melbourne[a] (Victoria, AUS)	**Suspended** during the pandemic	**Prerecorded**; **live streamed**	**Synchronous** small groups	**Yes**, for science students and graduate clinicians	**Asynchronous** discussion boards
University of New South Wales[a] **Sydney** (New South Wales, AUS)	**Suspended** during the pandemic	**Prerecorded** (2019) lectures, concept videos; **live-streamed** with discussion breakout rooms	**Asynchronous** with multimedia and formative assessment resources, followed by **synchronous** small group discussions	**Yes**, for medical students	**Asynchronous** discussion boards, anonymous Q&A, clinically applied adaptive tutorials; **Synchronous** live streamed small group sessions
University of Tasmania (Tasmania, AUS)	**Suspended** during the pandemic	**Online** short videos that include formative quizzes; Articulate Storyline Modules	**Asynchronous** pre-activity followed by **synchronous** review session	**No**	**Synchronous** live streamed review sessions with formative assessment
University of Western Australia[a] (Western Australia, AUS)	**Suspended** during the pandemic	**Prerecorded** (2018-2019) lectures	**Asynchronous** with multimedia sourced from YouTube and/or websites	**Undecided**	**Asynchronous** interactive lecture recordings; University of British Columbia (UBC) neuroanatomy modules
Western Sydney University (New South Wales, AUS)	**Suspended** during the pandemic	**Prerecorded** (2019-2020); **live streamed**	**Asynchronous** with multimedia resources	**Yes,** for forensic mortuary students	**Asynchronous** discussion boards; **Synchronous** live streamed small group sessions

[a]Member of the "Group of Eight" leading Australian research-intensive universities. Almost all donor programs were suspended in the face of the pandemic. Lectures typically relied on prerecorded material, a mix of asynchronous and synchronous teaching was used for practical modification. Active learning engaged large group webinars or discussion boards to facilitate class discussion; F2F, face-to-face.

component of their delivery. Of the 10 institutions included, six supported a teaching "pause" (Table 2). This provided students a short time to relocate to home, if appropriate. It also, even if notionally, acknowledged the significant work required from academic staff to change the mode of delivery within a limited timeframe, and gave credence to the ubiquitous messaging that the health and well-being of the university community is of primary importance, especially during the Covid-19 pandemic.

The urgency of the situation was evident in all narratives. Each anatomists' reflection tended to focus on identifying a

Table 2.

Support and Resources Provided During Pandemic Anatomy Teaching Preparation and Delivery

University (State, Country)	Digital resources supporting online learning	Sessional teaching staff engagement	Transition time provided	Pause in teaching to support transition
Australian National University[a] (Australian Capital Territory, AUS)	ANU-produced multimedia supplemented by external freely available resources	**Yes**, resource development, moderate online activities	None	**Yes**, for medical science; **No**, for medicine
La Trobe University (Victoria, AUS)	Acland's Anatomy[1], Visible Body[2], Anatomy.TV[3], and La Trobe image-based software	**Yes**, resource development	5 days	**Yes**, 1 week
Macquarie University (New South Wales, AUS)	Acland's Anatomy[1], Quizzes	**Yes**, resource development	10 days	**Yes**, mid-session break moved forwards
Monash University[a] (Victoria, AUS)	Proprietary, An@tomedia[4], Visible Body[2], Acland's Anatomy[1]	**Yes**, resource development, teaching delivery, assessment grading	4 days	**Yes**[b]
University of Otago (Dunedin, NZ)	Acland's Anatomy[1], Quizzes	**Undecided**	4 days	**Yes**, 4 days
University of Melbourne[a] (Victoria, AUS)	Proprietary, An@tomedia[4], Visible Body[2], Acland's Anatomy[1]	**Yes**, teaching delivery, assessments grading	1 week	**Yes**, after first two weeks of disruption
University of New South Wales[a] **Sydney** (New South Wales, AUS)	UNSW-produced multimedia and 3DVR, Visible Body[2], Acland's Anatomy[1], Sectra[5], Radiopaedia[6], Virtual Microscopy	**No**, not since F2F teaching ceased	None	**No**
University of Tasmania (Tasmania, AUS)	Virtual Microscopy, UTAS-produced content	**No**, not since F2F teaching ceased	None	**No**
University of Western Australia[a] (Western Australia, AUS)	Acland's Anatomy[1], YouTube available content	**Yes**, resource sourcing	None	**No**
Western Sydney University (New South Wales, AUS)	WSU-produced OPAL (Online Practical Anatomy Lab) quizzes, Visible Body[2], 3D4 Medical[7]	**Yes**, resource development, teaching delivery	None	**No**

[a]Member of the "Group of Eight" leading Australian research-intensive universities; [b]Year commencement delayed by 1 week, first week delivered fully online while the first day of the second week was face-to-face (F2F), and the remainder of the week paused. [1]Acland's Video Atlas of Human Anatomy® (Wolters Kluwer, Philadelphia, PA); [2]Visible Body© (Argosy Publishing, Inc., Newton, MA); [3]Anatomy.TV (Primal Pictures Ltd., Colchester, UK); [4]An@tomedia© (Anatomedia Publishing Pty Ltd. Richmond, VIC, Australia); [5]Sectra virtual dissection table (Sectra AB, Linköping, Sweden); [6]Radiopaedia.org© - an open edit radiology resource (UBM PLC, London, UK); [7]3D4Medical© (3D4Medical/Elsevier, Dublin, Republic of Ireland). Many Australian and New Zealand anatomy educators used digital resources to overcome the legal and ethical limitations related to human donor programs which often prohibit the sharing, photographing or recording of donor material. Some institutions were offered a brief (1 week) pause to convert a semester of teaching into online approaches, while many others were not. Despite typically engaging demonstrators only for F2F teaching, many institutions engaged sessional demonstrators in this transition – though their roles changed. While some still led online delivery of material, many were engaged to help develop resources for this pandemic anatomy teaching. 3DVR, three-dimensional virtual reality.

temporary solution, with many also incorporating and planning for future practical laboratory-based intensives (Table 2). The need for a balanced teaching approach, staff adaptability, and well-being support were discussed in nearly all reflections. As expected, some academics found the experience of accelerated change exciting and fruitful, while others found this experience daunting and worrisome. Universally, there were shared concerns about the extraordinary workloads this transition required. Some academics reported that even when commercially available material was used in teaching, the time spent curating and annotating this to ensure learning outcomes were met, was exorbitant. A reflection from one Australian colleague highlights the increased workload: "*Online teaching extends the working day and the working week (to now include weekend work); the volume of email has increased exponentially*."

Almost all academic anatomists reported that anatomy education is likely to change permanently given the scale of change during the pandemic, with some concerned that this change will call into question traditional laboratory-based approaches, in favor of modern (now trialed) online and remote learning approaches (Table 1). This concern was compounded as many academics reflected that these curricular changes, despite attention to quality, were a rapid response to an unprecedented situation, allowing little time for reflection and evidence-based refinement.

Challenges to Teaching Anatomy During a Pandemic

There were a variety of personnel-and infrastructural-related challenges shared across the Australian and New Zealand academics' reflections. These challenges fell into four categories: staff (faculty/academic staff and technical/professional staff), students, infrastructure and resources, and curriculum changes to accommodate online and/or remote delivery of anatomy education.

Challenges for Staff

With respect to personnel, there were multiple staff categories that were perceived to be affected by the pandemic teaching context; for all staff (regardless of previous role), there was a drastic change in the type of work that they were expected to do. The academic staff appeared to have the least professional role change, as many reported that they were, themselves, still focused on pedagogy; the expectations and skills for executing this new pedagogy, however, was different. A common challenge reflected on was that of information technology (IT) skills, and the lack of prior training or knowledge for effective online education delivery practices.

Technical staff and anatomy sessional staff/demonstrators (defined in Supplementary Table 1) were perceived as having some of the largest role transitions. Some anatomy educators noted that demonstrator roles changed from leading F2F small group discussions to that of digital media development and/or to small group instruction via streaming platforms such as Zoom® (Zoom Video Communications, Inc., San Jose, CA and Microsoft Teams® (Microsoft Corp., Redmond, WA) (Table 2). In contrast, other anatomists commented on the sudden elimination of the demonstrator role due to the pandemic's impact on university finances. Colleagues from one Australian university described their experience:

"*One of our first thoughts went to our casual demonstrators…This sudden change would remove their opportunity to extend their teaching experience, develop their knowledge and skills and reduce their income. To rectify this, we immediately instigated mechanisms to involve our demonstrators in the process of developing our remote learning opportunities … For one anatomy practical that required transformation into an online format in less than 24 hours, they [the demonstrators] came into the laboratory after hours to create demonstration videos*."

Technical staff appeared to similarly be learning new skills and pivoting their roles, as illustrated by another Australian anatomists' reflection:

"*Our tech[nical] team have been enlisted to create videos of rotating models so that students have at least a visual impression of these resources that are typically available to them in a resource area on each campus*."

Professional and technical staff faced the additional stresses related to job security. Initially this stress was related to the seemingly seamless way in which academic staff mobilized to deliver a program of online anatomy education, and was exacerbated when some departments took the strategic decision to temporarily suspend the body donor program due to uncertainty regarding the risk to Covid-19 exposure (Table 1). As the pandemic further unfolded, and with increased communications of university budget deficits, the future for professional staff remains tenuous. Interestingly, almost universally the academic anatomists' reflections included perceptions that both demonstrators and technical staff appeared to value these new roles and demonstrated skills of adaptability and resilience. The reflective narratives about the academics' own role (and role of their academic team) often also illustrated gratefulness for the flexibility of their peers.

A major challenge for all participating academic anatomists was the time investment to support the pandemic's curricular change. There were also many who reflected that the increased workload was not accompanied by the usual rewards of student interaction, a shared sentiment of the anatomy educators expressed in one anatomist's reflection:

"W*e go into these roles because we truly love watching students learn, not being able to see that in a traditional sense does make this workload harder*" and this was further explained by an anatomist from another institution: "*For some academics the anticipation of contact with students [in the usual F2F delivery] is something to look forward to, but this is difficult [during the pandemic] due to the city-wide physical distancing laws*."

As mentioned, some universities did "pause" teaching to accommodate the transition to online delivery (Table 2). This "pause" was for a relatively brief period (<1 or up to 2 weeks) considering the length of a semester (~10-13 weeks typically) and the number of learning activities that needed modification for online/remote learning. The challenge was compounded as universities moved to WFH, and with primary and secondary schools increasingly transitioning to home-based learning. This was an unprecedented experience and has meant that academics already working to difficult timelines with a challenging workload were also adjusting to WFH, and for some, with the additional tasks associated with concurrent childcare and home-schooling.

Challenges for Students

The academic reflections included a focus on perceived student-centered challenges. Academics expressed awareness of students concerns that centered around future degree

and career progression, across the participating universities. According to the academics, students appeared to face financial pressures due to lost income, resulting in concerns about university fees, and for many, a forced intermittence. Some of the perceived student challenges included managing student perceptions of "*missing out*" or "*getting what they [the students] paid for.*" There was an observation that these student concerns were at least, in part, due to the universities' messaging on expectations versus what was achievable by staff in the timeframe available, and within the pandemic education context. Also impacting these perceptions may be the pre-pandemic emphasis of anatomy education on, and the now lack of exposure to, human donor material, which is often perceived as a signature experience of the discipline. A colleague summarizes some of the student concerns:

"*Students were concerned about not having access to learning from human donors, which they perceived as the best opportunity to integrate concepts with the 'real' experience. The anatomy lab was where deep understanding of anatomy was achieved. Students further reported that they struggled without the F2F interaction with academics and tutors in the lectures and labs. In general, the student body was struggling with a lack of motivation without direct teacher interactions.... However, they [students] also highlighted the significant shift that they are making in a short time to adjust from F2F to online learning, and without the benefit of physical interactions with peers.*"

Academics themselves also had concerns about student learning, specifically around equity and access. This concern was compounded when considering the implementation of synchronous learning activities, and students' repatriating. This enforced geographical distancing meant that students were located across multiple time zones, with some returning to countries with restricted or poor internet access. Australia and New Zealand also have internet network accessibility and reliability limitations, particularly in rural and remote areas. Together, these potential learner challenges were considered in the redevelopment of Australian and New Zealand anatomy education, and (at least in part) accounts for the suite of synchronous and asynchronous activities (Table 2).

Resource Challenges

Regarding resources and infrastructure, the challenges expressed by anatomy educators are likely globally universal in university programs, including access to software and support for online teaching, technical failures, and network sustainability. However, unique to anatomy education are some of the ethical and medical considerations related to working with human donor resources. Multiple state/regional legislations pertain to body donor programs and consent for donation. Specifically, the ethical and legal constraints of sharing and displaying digital images of prosected human donor bodies/body parts, increased the challenges to anatomy online education in Australia and New Zealand; the net result was a reliance on proprietary digital anatomy resources (Table 2). In addition to the impacts on teaching, reflections communicated concerns about body donor programs sustainability and continued maintenance in the face of the present acute global health crisis.

Anatomy Curricular Changes

Anatomy lectures appeared to be the least complicated of all activities to translate in the pandemic, while anatomy practical experiences and assessments were consistently the most challenging to redesign across these two countries (Table 1).

Lectures. While some anatomy educators chose to livestream lectures on campus and/or from home, most chose prerecorded asynchronous approaches by re-using lecture recordings from previous years or developing new recordings. This decision reportedly allowed academics to focus effort on more complicated curricular translations (i.e., practical sessions and active learning), as noted by one reflection:

"*In the Covid-19 context, most course conveners released the pre-recorded lectures from the year before. This provided the opportunity for academics to have cognitive capacity to concentrate on upskilling their comfort with other technologies, and to reorganize material for the online space.*"

These prerecorded lectures were reportedly often supplemented with additional lecture material, which included short concept videos and formative assessments (Table 1). The sentiments expressed in many reflections was summed up by one colleague:

"*One strategic decision was to move away from big topics, by encouraging the breakdown of long lecture content into digestible chunks. The organization, search and review for existing digital material on [the] world wide web were additional tasks that were both time consuming and time 'robbing'.*"

Some academics incorporated interactive lectures, mirroring some of the active learning principles. Active learning, by definition, depends on student interaction to foster learning, and the opportunities for learner reflection (Haidet et al., 2012). Much effort was placed into translating these same principles online using interactive applications like Kahoot!© (Kahoot! A.S., Oslo, Norway) and Slido© (Slido s.r.o., Bratislava, Slovakia), and incorporating formative quizzes, live streaming, and applied anatomy tasks such as clinical case activities. One academic describes the active learning translation for a medical anatomy curriculum:

"*Our active learning sessions… allow for students' application of learned knowledge in the context of clinical uncertainty. To develop our online learning activities, we first asked ourselves what were core aspects we wanted to reproduce online? For us this included: Clinical reasoning, taking chances, and learning from peers. From this, it was decided to develop a series of discussion forums… We gave clear instructions on what was an appropriate approach to responding.... Students progression through [clinical] cases required them to work through the previous case, as would happen during the face-to-face active learning session… peers and facilitators were the primary source of feedback and re-direction if a student went off track, again emulating the teamwork needed for successful active learning. Once a learner had gone through each case, they were then able to access post-class videos which touched upon key anatomy knowledge.*"

Practical experiences. Many institutions reflected that student–teacher interaction was a desired attribute of practical sessions and replicating this online required supporting synchronous delivery experiences (Table 2). Many anatomists reflected a plan for intensive practical experiences post-pandemic to make up for the lack of exposure to authentic human donor resources during the remote learning phase (Table 1). Some of the shared university practical experiences is represented in one colleague's peer reflection:

"*For our practical experiences, we decided to focus on two key attributes, the short-term knowledge gains, and opportunities for students to be exposed to experts. We engaged the*

Zoom platform, because of its capacity to allow for user interaction. The medical imaging stayed much the same; herein demonstrators shared curated imaging, allowing students to use Zoom's "annotation" function to answer imaging identification questions…Tutorials were almost exactly the same with students engaging in presentations related to assigned learning objectives. The dissection component was the area that entirely changed."

Many institutions integrated practical videos, both prerecorded (pre-pandemic) and novel recordings were developed for supplementing the new synchronous online activities (Table 2). The purpose of the videos varied and were highlighted in a colleague's reflection:

"*Explanatory video to describe how and why we were making these changes, and how to use the four (three commercial and one in-house) online anatomy resources…[and] staff prepared additional short videos to emphasize key concepts for each weekly prac[tical] class using these online resources*."

Many used widely available videos from YouTube (YouTube LLC., San Bruno, CA) or proprietary anatomy software to minimize "*reinventing the wheel,*" but even this approach resulted in significant workload to both "*source appropriate videos*" and annotate them, with suggestions ranging from ~10 hours for a 2-hour active learning session to ~16 hours for a single practical conversion. For those who had already begun transitioning to technology-enhanced learning before the pandemic, the rapid online transition was perceived as a step backwards in their planned implementation as it was done with limited time for reflection and testing. Many also highlighted concerns that this rapid online shift may result in their institutions questioning the role of human donor material altogether.

Assessments. At the time of writing this report, assessments remained the most complicated and yet to be determined component of Australian and New Zealand anatomy education. Reflections from each university indicated that assessments were to be online. While online practical assessments have previously been effectively trialed (Inuwa et al., 2012), both the assessment approach and the platform for administration still needed to be determined within a short timeframe. The challenges were summarized in this statement: "*We want to ensure that our assessment is a true reflection of learning, remains robust, maintains integrity and is secure*." Some reflections also outlined a plan to prepare the student body for the anticipated changes to the assessment style: "*Any assessments that we deliver will be preceded by at least one formative examination in order to familiarize ourselves and the students with the online assessment process*."

Many academics shared awareness of student collusion risks and a difficulty with assessment invigilation; some translated this to developing assessments where collusion became irrelevant using variations of formative assessments or relative grading approaches. Other universities reported simply accepting collusion as inevitable in their solutions, as exemplified by one strategy in which assessment incorporated higher order questions:

"*The questions involve interpretation and analysis rather than recall of information and so whilst we cannot control students cheating, the nature of the questions reduces the likelihood of them locating the answer. If students collaborate then at least they have engaged together in reaching a solution*."

Others modified their assessment approaches to minimize the chances of collusion using, for example, "*Flag race tests [aka practical exams] … conducted [online with] randomized flags*." They report that: "*this now effectively becomes an open-book test, so to minimize collusion and maintain some academic rigor, the test will be run at a single time for all students and flags are randomized so that they [students] are not all getting the same question (even if they are sitting side by side.)*". One institution had further, in partnership with students in decision-making during the pandemic, implemented pass-fail grading reporting: "*Students were concerned that others in the student body would resort to extreme measures of colluding or compromise their academic integrity, which would be unfair on those who did no*t." Still others were adjusting assessment weighting to minimize the drive for collusion, and were considering sensitivities around what is being examined:

"*We are creating our own assessments deploying them [online] as timed low-stakes summative tests. Care must be taken to make sure non-sensitive images are used as students may screenshot and distribute questions*."

Even with these mitigating measures, assessment remains challenging—How do we build assessment with constructive alignment for pandemic anatomy education? Constructive alignment is based on constructivist theory wherein the learner constructs knowledge through learning activities which are pre-aligned with outcomes and assessment (Biggs, 2014). Adjusting assessments for students with learning disabilities and those requiring extra time for completing assessments further extends the complexity of ensuring a robust assessment practice delivered remotely, within a limited timeframe. This is further compounded when assessing a student body with heightened anxiety due to the constant media reporting and ever-changing circumstances presented by the pandemic.

Opportunities of Teaching Anatomy in the Pandemic

There were also some recognized opportunities that the pandemic presented including as previously noted, the rapid skill acquisition in online pedagogy (Schmidt et al., 2016) and skills in digital media production. With this in mind, and considering the changes already initiated in a short timeframe, the pandemic provided some with an impetus for curriculum review and strategic development of educational resources that would be useful after the pandemic, especially if these further enhance access and equity:

"*We are developing resources that can be utilized even when we are back to functioning normally. If the resources are aligned with the curriculum content and approach, then they can definitely supplement the practical classes …*"

Many reflections universally shared benefits such as gratefulness for both peers (staff) and students, and reported enhanced teamwork and skill acquisition of all involved (both staff and students). Of note, most participants reported a positive student response, even if this was initially negative. As the pandemic progressed, students increasingly responded to the anatomy learning experience with unsolicited positive feedback, and in some cases also with concern for staff.

DISCUSSION

The timing of the pandemic is of note for the island countries of Australia and New Zealand. The pandemic's "arrival"

coincided with the *beginning* of the 2020 academic year, a very different time to that of their northern hemisphere counterparts (who were nearing the end of the academic year). The implication of this, is that changes to the anatomy education delivery, even if only limited to the first half of 2020, potentially will have knock-on impacts across the entire academic year with respect to both curriculum delivery and assessment.

As the Covid-19 pandemic unfolds, and in the face of the significant disruption, the combined experiences and reflections of anatomy academics identify two main contributions to the practice of anatomical education in Australia and New Zealand. First, there are both opportunities and challenges presented with the rapid change in anatomy education, and there are related significant impacts on workload and professional roles. These were exemplified in the rapid upskilling of human resources, flexibility in redefining roles, and creativeness to enable and support continued learning at a distance. Second, there are the perceptions of the impact on pedagogy, technology, higher education institutions, staff, students, and, of course, on personal educational philosophies in both the short and long term. In this domain, concerns on the loss of an integrated "hands-on" laboratory experience, and the lack of being physically present, were raised. The insights into these two areas will have important implications for anyone contemplating anatomy education in the future.

While it is an unchartered time in the history of higher education, as always, there are lessons that can be gleaned from disruption, and anatomy education in Australia and New Zealand to accommodate the acute Covid-19 crisis presents several insights (Fig. 1).

Care of the Community

Of primary importance is the care of the whole community. Care should be taken to ensure that there is a safe environment. Change often creates anxiety for some, and rapid change in response to the Covid-19 pandemic is disruptive for both students and staff. For staff that deal with body donations, the pandemic raised concerns about both job security and risk of exposure if a body donor was a virus carrier. It is imperative that department leaders are aware of these concerns and find means to be "present" to engage in conversations and develop plans to mitigate risk to all constituents of the anatomy community. These concerns whether real or perceived, impact well-being. It is, therefore, imperative for department leaders to act quickly in circumstances where exposure to potential harm (e.g., SARS-CoV-2 virus) is unknown and to mitigate any threat to the health of the community, even if it requires temporary suspension of body donor programs.

Equally, student mental wellness is of concern to the academic anatomist, both prior to, and during the pandemic. While academics grapple with how to deliver anatomy education online, there needs to be an awareness that students who had previously experienced anatomy as a hands-on subject, or had preferred F2F learning, require support in the transition to learning remotely (Blackley and Sheffield, 2015). In this remote learning environment, the lack of physically present peers and instructors can lead some to have negative learning experiences. This raises concerns about the cognitive load placed on students through the change of learning environments, and whether the pace of change during the pandemic leaves too little mental capacity to construct knowledge (Schwonke, 2015). Ideally student learning in this new environment requires explicit monitoring of cognitive processes to minimize cognitive overload, as advocated by Valcke (2002). Broadbent and Poon (2015) highlighted, through systematic review, four strategies students require for online learning: time management, metacognition, effort regulation, and critical thinking. In the short time to transition to remote learning during the pandemic, providing structure was a key element of effective support for managing stress and anxiety, and anatomy educators used a variety of strategies to provide structure like scaffolding learning through structured weekly activities, packaging topics into digestible chunks to reduce cognitive load, the use of short concept videos and quizzes to regulate effort, and interactive synchronous learning to develop critical thinking and social interactions. From the authors experience, students have also been reassured by knowing that hands-on laboratory sessions would be provided post-pandemic to provide opportunities to review cadaveric prosected specimens and surface and living anatomy, and possibly undertake dissection.

Clear and Effective Communication

One of the challenges of the current landscape is that messaging understandably appears changing, unclear and often conflicting. Clearly communicating, even when the answer is still being discussed, is essential and will ensure reciprocity and cooperation among students (Chickering and Gamson, 1989). As academics, who were also managing change for students, modelling effective communication strategies and approaches is useful to alleviate any change-induced stress. Communication of expectations, as well as simple guidance on managing the online space is of great importance and can make a positive impact on learning (Broadbent and Poon, 2015). Some examples of this include clarifying the expectations around the expected daily/weekly progress and assessment criteria, and providing formative assessment opportunities as a preamble to high-stakes assessment tasks, as highlighted by the academics' reflections. In the light of increased student anxiety during the pandemic, communications should be carefully framed within positive messages of support and in a context of open dialogue. Useful strategies employed during the pandemic included using anonymous dialogue platforms like Slido© to allow students to ask questions in the comfort of anonymity, discussion boards to enable asynchronous student–teacher interactions (Green and Hughes, 2013), and including students in the decision-making process affecting aspects of anatomy delivery, for example, assessments. Of note, during this pandemic education delivery, both the academic staff and students described a loss of in person interaction and its impact on their individual motivation. While this has previously been connected to student disengagement in the online learning environment (Gillett-Swan, 2017), the impact of this loss on staff has only recently been reported in the context of embedded-reward systems in higher education (Cuseo, 2018).

Clarifying Expectations on Workloads

As workloads and roles morph, effective change management strategies can be helpful, including clarifying stakeholder expectations. This is especially important given the increasing concern over the last two decades about mental wellness among

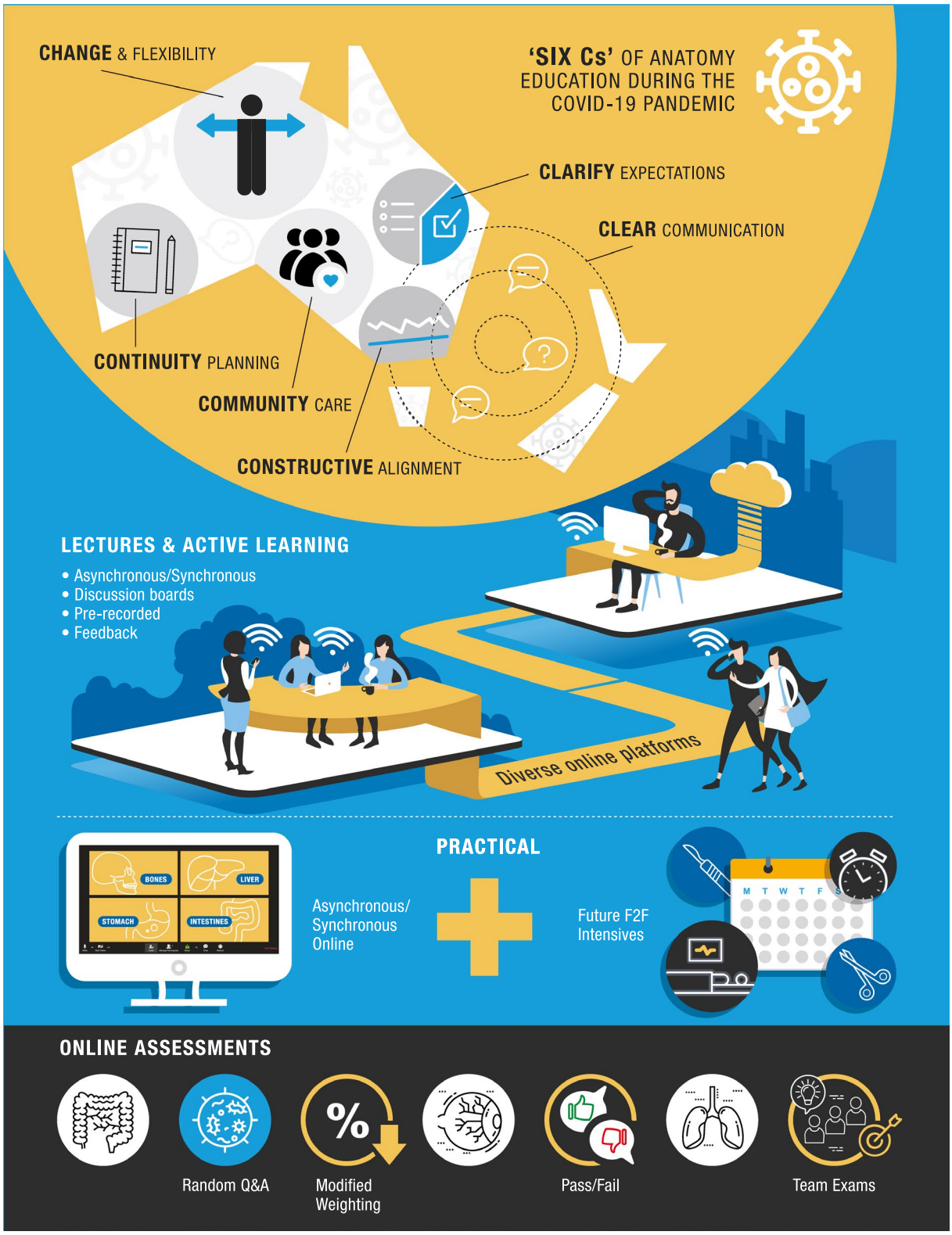

Figure 1.

Infographic of shared Australian and New Zealand anatomy education teaching approaches during the Covid-19 pandemic. Scoping implications for this teaching crossed multiple teaching modalities summarized as the six Cs, and affected all stakeholders (students and staff) including: change and flexibility, clarify expectations, clear communication, constructive alignment of new material, a focus on community care, and continuity planning in the face of this global health emergency. Lectures and active learning tended to engage asynchronous online approaches, using prerecorded videos and discussion boards, while practical activities tended to be synchronous streaming approaches combined with a reliance on future intensive experiences. Assessment was the most widely varied aspect across these two countries. All approaches tended to accept collusion as a risk to online assessments, and educators attempted to mitigate this risk by delivering questions with randomized sequencing for each student, decreasing weighting of assessments, making assessments pass or fail, or embracing teamwork as part of the assessment strategy.

university academics even in the absence of a crisis (Watts and Robertson, 2011; Gulliver et al., 2017; Kinman, 2019). Existing evidence suggests that academics are already overcommitted to their work due to implicit system rewards (Hamilton, 2019). In the absence of a pandemic, the increase in educators' workloads in developing online resources (Green and Whitburn, 2016) and in transitioning to remote and online delivery (Kimball, 1998) is well recognized. Managing and supporting students has been identified as the most demanding aspect of digital learning (Canninzzo et al., 2019). This correlates with the reflections of a large number of participants regarding the increased workload, the extended online work day/week, and the increased student correspondence. Regarding the latter, Kimball (1998) explains that in remote learning, learners have a perception of a "rolling presence" which can make educators feel pressured to spend large amounts of time interacting with students who perceive online education as "always open" for business. The social and personal impact of the rapid response by anatomy academics to transform to a highly demanding form of delivery (i.e., distance/online) is yet to be determined. It is reasonable to expect that discussions and plans to reset stakeholder expectations will be required, especially if this pandemic continues for an extended period.

As workloads explode, there is a need for leaders to provide immediate assurance, acknowledgement of the situation and empathy for the challenges faced with rapid change. Those in leadership roles, have the added responsibility to advocate for staff, especially considering high expectations and the complexities of WFH arrangements. Clarifying expectations of academics is imperative. For academic colleagues, it is impossible to quantify the time required for repurposing and sourcing resources, but acknowledging this reality is useful, as is acknowledging all who contribute to delivering the learning experience.

Constructive Alignment

In good education practice, constructive alignment is paramount. In a pandemic, alignment, if clearly articulated, will potentially aid students in making meaning of the change and will be reassuring and decrease anxiety. In delivering anatomy education remotely and online within a changing pandemic landscape, constructive alignment remains a challenge; a simple effective process to ensure alignment with learning outcomes, activities, and assessment is, however, required. As Saunders (2020) posits, distance teaching requires teaching practices to change, and "to change the way in which you teach is a significant undertaking." There are several fundamental elements of effective online pedagogy design (Chen et al., 2005; Martin and Bolliger, 2018) employed in delivering anatomy teaching during the pandemic, these elements were variably highlighted and included providing feedback through quizzes, establishing social connections, active facilitation and using a range of technologies. One approach highlighted selecting a pedagogical element to emphasize through the delivery (e.g., active learning) rather than focusing on issues such as infrastructure, policies and budget. Even with this foresight, the aspect of remotely delivering assessment requires more deliberation, and institutional resources (Kirkwood and Price, 2014). It is expected that this is an area that Australian and New Zealand universities will need further investment in.

At some stage, once the crisis is over, activities undertaken now will have to be reviewed. For this reason, clear documentation of expectations and modifications made (what, why, and how) will be useful. There is, however, little opportunity with the present pace of change, for an adequate change documentation process. Uncertainties also remain around *how* documentation will be reviewed by professional accreditation bodies, and for Australia, TEQSA. No doubt there will need to be a targeted program of evaluating competencies and providing in-time education to address any perceived learner knowledge gaps. It is hoped that this compensatory process will also heed the evidence on the benefits of cadaveric-based learning for medical students (Estai and Bunt, 2016; Flack and Nicholson, 2018). It will, however, be important to determine what perceived gap, if any, is being addressed before a compensatory activity is planned (Wilson et al., 2019). At that stage, and with time, there will also be opportunity to evaluate whether other digital resources and immersive Learning experiences can be used to address knowledge gaps (Doubleday et al., 2011; Losco et al., 2017; Birbara et al., 2020).

Compromise, Adapt, and Be Flexible

As we cope with this pandemic, being able to compromise, and adapt in practice and curriculum design and teaching delivery is important. Anatomy academics' reflections on persevering and adapting to deliver anatomy education amidst constant and daunting change is possibly an indication of a commitment of anatomy educators to the education sector, student body, and discipline. Given the limited time available for transition to remote/online delivery, the authors experiences demonstrated an almost consistent strategy of repurposing existing material. This enabled academics to concentrate on redesigning activities related to higher learning outcomes usually attained through the practical components of learning in the anatomy laboratory. Some anatomy educators planned later opportunities after the pandemic to address perceived gaps in knowledge.

Evidence suggests that the quality of remote learning materials needs to be higher than campus-based materials (Kimball, 1998) and this has been corroborated more recently in the practice of developing online content for a blended anatomy course (Green and Whitburn, 2016). However, an important aspect of pandemic change for anatomy academics themselves is to adapt self-imposed standards. It will take confidence to heed calls to compromise self-imposed excellence standards. As Saunders (2020) explains, academics incur additional stress in online teaching with the increased pressure that prerecorded videos, case studies, and discussion boards are a permanent record of their knowledge and expertise. Given the context of the pandemic, and the speed of change, it befits entire academic community to model self-care and moderation to those around, and to accept that current makeshift resources may not be a true reflection of the educators' abilities, but it will be fit-for-purpose in response to acute transitional change.

Community of Practice

One of the challenges of change in the paradigm of physical distancing regulations, is that it almost instantly cauterized the existing community of practice academics access in their home departments and institutions. Anatomy academics, however, appear to be resourceful in effectively engaging with a wider community of practice to share not just experiences and capabilities but also resources. This was evidenced in the almost immediate role change of technical staff and demonstrators to

develop digital resources, and through the sharing of resources and of experiences using social media communities (e.g., Twitter Inc., San Francisco, CA) and by software developers and societies of anatomy (Evans et al, 2020). Smaller communities like local departments of anatomy, have also utilized technologies such as WhatsApp© (Facebook Inc., Mountain View, CA), to troubleshoot through challenges, and motivate and aid staff well-being. As in past times of crisis, a positive outcome of the shared challenge is that it unifies communities around common goals. While this is certainly a time of justified anxiety, it is also a time when the positive and resilient aspects of connectedness and community come together to encourage and build each other up—even with physical distance. Notwithstanding this, the rapid onset of the Covid-19 pandemic, highlights the need for the discipline and for departments to be proactive in keeping updated with new pedagogies and to be embedded in wider communities of practice outside home institutions.

Continuity Planning

As negative as it sounds, it is essential at this time (as at any) to develop and communicate a continuity plan. In a global health emergency, circumstances are likely to arise that a team member is unable to continue their responsibilities. Inevitably, the pandemic highlights to those in leadership roles, the need for contingency planning and investment in staff upskilling. The disruption of anatomy education in response to the pandemic may, however, also be perceived as an opportunity to expand anatomy education more broadly beyond the traditional F2F delivery model into the remote learning space. Fully online models of anatomy education may have been impeded over the last decade by the lack of acceptance among anatomy educators. The quick response of the anatomy community in Australia and New Zealand demonstrates their flexibility and potentially enables the discipline to personalize education (Gillett-Swan, 2017) and to expand its reach to untapped learner pools, an increasingly important need as institutions enter a post-pandemic financial recovery phase. No doubt that whatever the context, the main inhibitor of remote anatomy education delivery will be the quality of the offering especially if deficient of a hands-on practical experience, time, support, and people capacity. Some of the benefits of the pandemic-related disruption are already being recognized and include, for example, using live streaming to deliver lectures to cohorts of students distributed across multiple (sometimes even remote) campuses during clinical placements, thus addressing a challenge experienced by most Australian and New Zealand anatomy departments. This model could also assist students on extended periods of absence, like for example indigenous students attending community and family ceremonies and funerals. Some anatomy academics have, indeed, perceived this rapid change as a novel opportunity to apply newly learnt pedagogies and delve into a freshly acquired space for modern education.

Limitations of the Study

There remain several limitations of this current profile of anatomy education during the early stages of the pandemic. While it uniquely captures a cross-section of experiences of delivering anatomy education in Australia and New Zealand, the reflections were not triangulated, and it does not include all anatomists or all anatomy departments in Australia and New Zealand. Importantly, the participants narratives are a snapshot of their perceptions and views based on a one-off reflection during a period of crisis, and not a longitudinal account of their experiences. The constructivist approach to the study is an appropriate tool to examine anatomy education in the rapidly changing context of the pandemic, as it allows interpretation of experiences at different time points. A follow-up study with the participants post-pandemic would, therefore, provide deeper insights on how academic attitudes in this period of acute change have changed and matured, and how the experience has impacted their personal educational philosophies and their institutional practice of anatomy education.

CONCLUSION

As the Covid-19 pandemic continues to unfold in Australia and New Zealand, there is no doubt that university leaders and academics deserve recognition for their management and support to all the communities that they serve. Their focused efforts in the face of global change, disruption, uncertainty, and potential volatility appears to ensure an effective and safe learning environment, and where possible, serve their nations and their institutions. For anatomy education, these decisions were particularly impactful in that they disrupted access to human donor body resources (a widely utilized discipline pedagogical tool) and forced change to ensure the continued delivery of anatomy teaching. Several challenges were recognized by anatomy academics in this period including time, resources, and technical capability. Professional and technical staff demonstrated role adaptability and assisted their academic colleagues in meeting teaching obligations. For anatomy academics, flexibility and adaptability enabled the continuity of anatomy education programs which were effectively fit-for-purpose in the pandemic context. Interestingly, in person interactions between anatomy academic staff and students, an often-overlooked motivator, was uniquely highlighted as an integral part of the anatomy learning equation. Of note, and in a time of crisis and uncertainty, anatomists appear to act and think like leaders—health and safety first, followed by academic standards, and developing flexible solutions for business continuity. There is no doubt that there has been a significant change in the teaching of anatomy in Australia and New Zealand over the last month. It remains, however, to be seen how the rapid change effected at this time correlates with student performance and satisfaction, and how the bridges that have been built impact on the future of anatomy education.

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LITERATURE CITED

Barry CA, Britten N, Barber N, Bradley C, Stevenson F. 1999. Using reflexivity to optimize teamwork in qualitative research. Qual Health Res 9:26–44.

Biggs J. 2014. Constructive alignment in university teaching. HERDSA Rev High Educ 1:5–22.

Birbara NS, Otton JM, Pather N. 2019. 3D modelling and printing technology to produce patient-specific 3D models. Heart Lung Circ 28:302–313.

Birbara NS, Sammut C, Pather N. 2020. Virtual reality in anatomy: A pilot study evaluating different delivery modalities. Anat Sci Educ (in press; https://doi.org/10.1002/ase.1921).

Blackley S, Sheffield R. 2015. Digital andragogy: A richer blend of initial teacher education in the 21st century. Issues Educ Res 25:397–414.

Broadbent J, Poon WL. 2015. Self-regulated learning strategies and academic achievement in online higher education learning environments: A systematic review. Internet High Educ 27:1–13.

Canninzzo F, Mauri C, Osbaldiston N. 2019. Moral barriers between work/life balance policy and practice in academia. J Cult Econ 12:251–264.

Chen NS, Ko HC, Kinshuk, Lin T. 2005. A model for synchronous learning using the Internet. Innovat Educ Teach Int 42:181–194.

Chickering AW, Gamson ZF. 1989. Seven principles for good practice in undergraduate education. Biochem Educ 17:140–141.

Colibaba AS, Calma AD, Webb AL, Valter K. 2017. Exploring deep space - Uncovering the anatomy of periventricular structures to reveal the lateral ventricles of the human brain. J Vis Exp 128:e56246.

Collignon P. 2011. Swine flu: Lessons we need to learn from our global experience. Emerg Health Threats J 4:7169.

Cuseo J. 2018. Student–faculty engagement. New Dir Teach Learn 2018:87–97.

Davies A, Karp P. 2020. A downward spiral: Coronavirus spins Australian universities into economic crisis. The Guardian. 14 April 2020. Guardian News & Media Limited. Sydney, Australia. URL: https://www.theguardian.com/australia-news/2020/apr/14/a-downward-spiral-coronavirus-spins-australian-universities-into-economic-crisis.

de Wit E, van Doremalen N, Falzarano D, Munster VJ. 2016. SARS and MERS: Recent insights into emerging coronaviruses. Nat Rev Microbiol 14:523–534.

Doubleday EG, O'Loughlin VD, Doubleday AF. 2011. The virtual anatomy laboratory: Usability testing to improve an online learning resource for anatomy education. Anat Sci Educ 4:318–326.

Estai M, Bunt S. 2016. Best teaching practices in anatomy education: A critical view. Ann Anat 208:151–157.

Evans DJ, Bay BH, Wilson TD, Smith CF, Lachman N, Pawlina W. 2020. Going virtual to support anatomy education: A stop gap in the midst of the COVID-19 pandemic. Anat Sci Educ 13:279–283.

Evans DJ, Pawlina W, Lachman N. 2018. Human skills for human[istic] anatomy: An emphasis on nontraditional discipline-independent skills. Anat Sci Educ 11:221–224.

Ferguson H, Sherrell H. 2019. Overseas Students in Australian Higher Education: A Quick Guide. Parliamentary Library Research Papers Series. 20 June 2019. 1st Ed. Canberra, ACT, Australia: Parliament of Australia. 12 p. URL: https://parlinfo.aph.gov.au/parlInfo/download/library/prspub/6765126/upload_binary/6765126.pdf [accessed 15 April 2020].

Flack NA, Nicholson HD. 2018. What do medical students learn from dissection? Anat Sci Educ 11:325–335.

Gillett-Swan J. 2017. The challenges of online learning: Supporting and engaging the isolated learner. J Learn Design 10:20–30.

Green RA, Hughes D. 2013. Student outcomes associated with use of asynchronous online discussion forums in gross anatomy teaching. Anat Sci Educ 6:101–106.

Green RA, Whitburn LY. 2016. Impact of introduction of blended learning in gross anatomy on student outcomes. Anat Sci Educ 9:422–430.

Green RA, Whitburn LY, Zacharias A, Byrne G, Hughes DL. 2018. The relationship between student engagement with online content and achievement in a blended learning anatomy course. Anat Sci Educ 11:471–477.

Gulliver A, Farrer L, Bennett K, Griffiths KM. 2017. University staff mental health literacy, stigma and their experience of students with mental health problems. J Further High Educ 43:434–442.

Haidet P, Levine RE, Parmelee DX, Crow S, Kennedy F, Kelly PA, Perkowski L, Michaelsen L, Richards BF. 2012. Perspective: Guidelines for reporting team-based learning activities in the medical and health sciences education literature. Acad Med 87:292–299.

Hamilton JE. 2019. Cash or kudos: Addressing the effort-reward imbalance for academic employees. Int J Stress Manag 26:193–203.

Harden RM. 2006. International medical education and future directions: A global perspective. Acad Med 81:S22–S29.

Hildebrandt S. 2019. The role of history and ethics of anatomy in medical education. Anat Sci Educ 12:425–431.

Ho VW, Meng M, Hwang GJ, Pather N, Kumar RK, Vickery RM, Velan GM. 2019. Knowledge maps: An online tool for knowledge mapping with automated feedback. Med Sci Educ 29:625–629.

Inuwa IM, Taranikanti V, Al-Rawahy M, Habbal O. 2012. Anatomy practical examinations: How does student performance on computerized evaluation compare with the traditional format? Anat Sci Educ 5:27–32.

Johnston M. 2020. Online mass exodus: How Australian unis are coping with COVID-19. ITNews. 20 March 2020. Information Technology News, Next Media Pty Ltd., St Leonards, New South Wales, Australia. URL: https://www.itnews.com.au/news/online-mass-exodus-how-australian-unis-are-coping-with-the-covid-19-pandemic-539630 [accessed 28 April 2020].

Kimball L. 1998. Managing remote learning: New challenges for faculty. In: Hazemi R, Hailes S, Wilbur S (Editors). The Digital University: Reinventing the Academy. 1st Ed. London, UK: Springer-Verlag London Ltd. p 25–38.

Kinman G. 2019. Effort-reward imbalance in academic employees: Examining different reward systems. Int J Stress Manag 26:184–192.

Kirkwood A, Price L. 2014. Technology-enhanced learning and teaching in higher education: What is 'enhanced' and how do we know? A critical literature review. Learn Media Tech 39:6–36.

Kumar Ghosh S, Kumar A. 2019. Building professionalism in human dissection room as a component of hidden curriculum delivery: A systematic review of good practices. ASE 12:210–221.

Losco CD, Grant WD, Armson A, Meyer AJ, Walker BF. 2017. Effective methods of teaching and learning in anatomy as a basic science: A BEME systematic review: BEME guide 44. Med Teach 39:234–243.

Martin F, Bolliger DU. 2018. Engagement matters: Student perceptions on the importance of engagement strategies in the online environment. Online Learn 22:205–222.

Nowell LS, Norris JM, White DE, Moules NJ. 2017. Thematic analysis: Striving to meet the trustworthiness criteria. Int J Qual Meth 16:1–13.

O'Rourke JC, Smyth L, Webb AL, Valter K. 2020. How can we show you, if you can't see It? Trialing the use of an interactive three-dimensional micro-CT model in medical education. Anat Sci Educ 13:206–217.

Otton JM, Birbara N, Hussain T, Griel G, Foley TA, Pather N. 2017. 3D printing from cardiovascular CT: A practical guide and review. Cardiovasc Diagn Ther 7:507–526.

Pather N. 2015. Teaching anatomy: Prosection and dissection. In: Chan LK, Pawlina W (Editors). Teaching Anatomy. A Practical Guide. 1st Ed. New York, NY: Springer International Publishing. p 213–221.

Perpitch N. 2020. Coronavirus travel ban hits Australian universities, schools as Chinese students stranded overseas. ABC News, 19 February 2020. Australian Broadcasting Corporation, Government of Australia, Ultimo Sydney, Australia. URL: https://www.abc.net.au/news/2020-02-14/peter-dutton-defends-government-extending-china-travel-ban/11964916 [accessed 15 April 2020].

Rees CE, Crampton PE, Monrouxe LV. 2020. Re-visioning academic medicine through a constructionist lens. Acad Med (in press; https://doi.org/10.1097/ACM.00000 00000 003109).

Saunders N. 2020. Reducing regulatory burden during COVID-19 – Important update from TEQSA. Australian Government Tertiary Education Quality and Standards Agency (TEQSA). Coronavirus (COVID-19) Sector Update. 26 March 2020. Australian Government, Canberra, ACT, Australia. URL: https://www.teqsa.gov.au/reducing-regulatory-burden-during-covid-19-important-update-teqsa [accessed 8 April 2020].

Schmidt SW, Tschida CM, Hodge EM. 2016. How faculty learn to teach online: What administrators need to know. Online J Dist Learn Admin 19:1–10.

Schwonke R. 2015. Metacognitive load - Useful, or extraneous concept? Metacognitive and self-regulatory demands in computer-based learning. J Educ Technol Soc 18:172–184.

Simonson M, Schlosser C, Orellana A. 2011. Distance education research: A review of the literature. J Comput High Educ 23:124–142.

Stephens GC, Rees CE, Lazarus MD. 2019. How does donor dissection influence medical students' perceptions of ethics? A cross-sectional and longitudinal qualitative study. Anat Sci Educ 12:332–348.

Štrkalj G, Pather N (Editors). 2017. Commemorations and Memorials: Exploring the Human Face of Anatomy. 1st Ed. Singapore, Singapore: World Scientific Publishing Co., Pte. Ltd. 204 p.

Truu M. 2020. Australian universities defer exams, increase response to coronavirus outbreak. SBS News. 29 January 2020. Special Broadcasting Service. Government of Australia. Artarmon, New South Wales, Australia. URL: https://www.sbs.com.au/news/australian-universities-defer-exams-increase-response-to-coronavirus-outbreak [accessed 8 April 2020].

Valcke M. 2002. Cognitive load: Updating the theory? Learn Instr 12:147–154.

Watts L. 2016. Synchronous and asynchronous communication in distance learning: A review of the literature. Q Rev Distance Educ 17:23–32.

Watts J, Robertson N. 2011. Burnout in university teaching staff: A systematic literature review. Educ Res 53:33–50.

WHO. 2020. World Health Organization. Coronavirus Disease 2019 (COVID019) Situation Report – 39. 28 February 2020. Geneva, Switzerland: World Health Organization. 7 p. URL: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200228-sitrep-39-covid-19.pdf?sfvrsn=5bbf3e7d_4 [accessed 8 April 2020].

Wilson AB, Brown KMB, Misch J, Miller CH, Klein BA, Taylor MA, Goodwin M, Boyle EK, Hoppe C, Lazarus MD. 2019. Breaking with tradition: A scoping meta-analysis analyzing the effects of student-centered learning and computer-aided instruction on student performance in anatomy. Anat Sci Educ 12:61–73.