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Influence of COVID-19 restrictions on student satisfaction with undergraduate pathology teaching in an Australian University

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Introduction: Almost three years into the COVID-19 pandemic, it is important to reflect on student perceptions of online teaching, and more specifically, if mobility restrictions imposed as public health measures significantly influenced how students perceived online teaching. The aim of this study was to investigate if student perceptions of teaching quality of undergraduate courses would differ when evaluated at times of increasing or relaxing COVID-related mobility restrictions.

Methods: We compared student feedback for two third-year undergraduate Pathology courses taken as part of a Bachelor of Medical Sciences / Science degree in an Australian University from 2019 to 2021. Quantitative feedback on five domains (overall satisfaction, belongingness within a learning community, satisfaction with assessments, adequacy of learning resources, satisfaction with teacher feedback) were categorized into groups based on calendar year or prevailing COVID restrictions (times with no, increasing or relaxing restrictions), and compared. There were no significant changes to the course content during this time, but face-to-face teaching in 2019 changed to predominantly online teaching in 2020 and 2021.

Results: Feedback scores were significantly better ($p < 0.017$) at times of increased COVID restrictions compared to times with relaxing COVID restrictions across all five domains assessed. Interestingly, when grouped by calendar years (instead of prevailing COVID restrictions), there were mostly no significant differences in the feedback scores, despite the shift to online teaching in 2020/21.

Conclusion: At times of increasing mobility restrictions, students may appreciate the consistency offered by well-structured online teaching but when restrictions are relaxed, online-only teaching may not meet their expectations. The teaching methods need to adapt to prevailing situation by focusing on more hands on and face-to-face teaching when circumstances allow it.

KEYWORDS

Australia, pathology, COVID-19, online teaching, student experience

Introduction

The SARS-2-nCoV (COVID-19) pandemic is an evolving situation with an unprecedented global economic and social impact. It has not spared the higher education sector. A survey by the International Association of Universities, which received more than 20,000 responses from students and teachers, identified that nearly 53% of international students were grounded in foreign institutions (International Association of Universities and Erasmus Student Network, 2020). UNICEF estimates that nearly 1.5 billion students (of schools and Universities) in 190 countries have lost access to regular teaching and learning. Locally in Australia, the University sector is facing a collective loss of up to \$19bn between 2020 and 2023 due to border closures restricting movement of both local and international students (Business News Australia, 2020). While the numbers are often reported representing the “big picture,” the challenges faced by students and teachers at a local or micro-level are often overlooked.

Over the past 18 months, COVID-19 related restrictions (e.g., curfews, lockdowns, travel restrictions and border closures) had hindered peoples' mobility from time to time. As a result, schools and Universities in many countries resorted to online learning (Adedoyin and Soykan, 2020). However, educational institutions that had previously invested in e-learning, blended and flipped classrooms were likely to have made this transition more effectively than others (Bartolic et al., 2021; Cahyadi et al., 2021). Furthermore, online teaching introduces inequities given the costs of receiving online education, and global and regional (urban vs. rural) differences in internet coverage or speed (Cahyadi et al., 2021). On top of this, adverse mental health and social effects of the pandemic such as isolation from family members and friends, loss of income, fear of illness, being stranded overseas, and feelings of uncertainty about the future may affect how students perceive the quality of the education they receive (Almhdawi et al., 2021; Kelly et al., 2021; Natalia and Syakurah, 2021), and such perceptions may change with time depending on the pessimism or optimism induced by the increasing or relaxing COVID-related mobility restrictions. Hence, students may evaluate the same course differently despite there being no major changes to the content taught.

We hypothesized that students will be more satisfied with courses adapted to e-learning prior to the pandemic (henceforth referred to as online-ready courses) at times of increased uncertainty and increased mobility restrictions (because they transition better to full online teaching), but will be less satisfied with the same courses when restrictions are relaxed, despite there being no major changes to the course content or teachers. This study aims to test this hypothesis by evaluating the student feedback for two third year

online-ready undergraduate Pathology courses at University of New South Wales in Sydney (UNSW Sydney) over 3 years from pre-pandemic (2019) to pandemic (2020, 2021) times with periods of increasing or relaxing mobility restrictions.

Materials and methods

The courses

This study focusses on two third-year undergraduate Pathology courses titled “Molecular Basis of Disease” (course code: PATH3205) (UNSW Sydney, 2021a) and “Cancer Pathology” (course code: PATH3206) (UNSW Sydney, 2021b). These courses are offered in the Bachelor of Medical Sciences / Science degree programs (not the medical degree program), and both are mandatory third year courses for graduating with a Pathology major. Both courses typically have enrolments in the range of 70–115 students per iteration and each course is run once a year (each for a duration of one 10-week term and earns 6 units of credit). UNSW Sydney has a three-term (T1–T3) academic teaching calendar and PATH3205 runs in T1 (March–May) while PATH3206 runs in T2 (June–August). There is a significant overlap of students (77%–82%) taking both courses in a calendar year.

Both these courses, though significantly different in the content taught, share many similarities (Table 1) in teaching pedagogy, learning activities, assessment tasks, and the same teaching group in the Department of Pathology, Faculty of Medicine and Health, UNSW teach and administer them. Both courses underwent a major restructure of content and method of delivery (more focus on blended and e-learning) in 2017–2018, with no further significant curricular changes during the period analyzed here (i.e., 2019–2021). By 2019 (last iteration delivered fully face-to-face), except for two practical classes in PATH3205, all other activities in both courses were ready to be delivered online, if needed. For example, all lectures were recorded (it is not mandatory to physically attend lectures), tutorials were conducted face-to-face (F2F) but each class worked on communal notes using documents hosted on a cloud server (e.g., Google docs, MS Word online), and the practical classes were redesigned to be online ready using e-learning resources¹ such as virtual slides (Kumar et al., 2006; Herbert et al., 2017) and virtual macroscopic pathology specimens.² Practical class re-design for PATH3206

1 <https://www.best.edu.au/>

2 <https://iod.med.unsw.edu.au/>

TABLE 1 Similarities and differences between the two Pathology courses evaluated in this study.

Item	Course 1	Course 2
Name	Molecular Basis of Disease	Cancer Pathology
Course code	PATH3205	PATH3206
Frequency	Once a year in Term 1 (March–May)	Once a year in Term 2 (June–August)
Units of Credit	6	6
Mandatory for a Pathology Major	Yes	Yes
Duration	10 weeks	10 weeks
<i>Teaching activities</i>		
Lectures	2–3 h per week	2–3 h per week
Tutorials	5, each for 1.5 h	9, each for 1 h
Practical classes	5, each 1.5–2 h	6, each 2 h
<i>Assessments*</i>		
Continuous	5 Moodle quizzes, each with 10 MCQs (15% of course total)	5 Moodle quizzes, each with 10 MCQs (10% of course total)
Mid-term exam	Yes (15% of course total)	Yes (20% of course total)
Assignment	Group project to produce a presentation (30% of course total)	Group project to produce a presentation (30% of course total)
End-of-course exam	Yes (40% of course total)	Yes (40% of course total)

*All assessments were online open book assessments in 2020 and 2021.

using a novel narrative-based approach has been published previously (Rodrigo et al., 2019). Teaching pedagogy in the Department of Pathology focusses on student-centred learning for both tutorials and practical classes, where students work in small groups (5–6 students per group) to solve problems and time ratio between lectures and group-based activities (practical classes and tutorials) had been adjusted in favour of the latter (2.3 h per week). The assessment structure in both these courses were similar (Table 1).

Student feedback

Student feedback is obtained *via* multiple methods in both these courses (e.g., formal meetings with student representatives, formal end-of-course evaluations named “myExperience,” lecture style feedback discussions after the mid-term examination, and informal communications with students). However, for the purpose of this study only student feedback obtained through the myExperience survey is considered as it is a consistent, independently administered, university-wide, standardised tool for evaluating student feedback (UNSW Sydney, 2021c). All students enrolled in a course at UNSW are invited to participate in this anonymous online survey in the last 2 weeks of the course. The survey closes before the final examination and the feedback is sent to teachers after the

examination results are released. Each myExperience survey has a quantitative and a qualitative component, and five questions of the quantitative component (henceforth referred to as “domains”) had remained the same over the three-year period evaluated in this study. These 5 questions asked about: (Q1) overall satisfaction with the course, (Q2) if the students felt as part of a learning community, (Q3) if feedback from teachers helped in learning, (Q4) if the course resources helped in learning, and (Q5) if the assessments were appropriate. The responses to each of these questions are graded in a scale ranging from 1 to 6 (1 = Strongly Disagree, 2 = Disagree, 3 = Moderately Disagree, 4 = Moderately Agree, 5 = Agree, 6 = Strongly Agree). The qualitative component of the survey allows the students to enter free text in response to the following questions: (a) What were the best things about this course? and (b) What can be improved? In 2020, these questions were slightly altered as (a) What were the best aspects of studying online? and (b) What were the challenging aspects of studying online?

Impact of COVID-19 on the teaching and assessment of PATH3205 and PATH3206

UNSW main campus is in metropolitan Sydney in the State of New South Wales in Australia. Sydney is the most populous city in Australia. In March–April of 2020 a strict COVID-lockdown was imposed in Sydney and PATH3205, the T1 course running at that time, successfully adapted to this challenge by going fully online within 24 h. The pre-existing blended class structure and heavy use of e-learning favored this transition (Supplementary Table 1). By June and July in 2020 (T2) the case numbers in Sydney declined and restrictions were relaxed. However, the T2 course PATH3206 was still run fully online despite the relaxing of restrictions. By 2021 T1, there were minimal or no COVID related restrictions in Sydney and community acquired cases were zero on most days. Students and teaching staff returned to campus, and PATH3205, run in T1 of 2021 offered online live lectures, hybrid tutorials (F2F teaching with online streaming) and hybrid practical classes (students could come to campus and sit with each other to watch a practical demonstration streamed in real time, but not in the same room). However, given that some students remained interstate or overseas, the course did not return to full face-to-face teaching as done in 2019. Unfortunately, in June 2021, case numbers surged again in Sydney due to the spread of SARS-nCoV-2 delta variant, and strict lockdown restrictions (mobility of people restricted to 5–10 km from their home) were reimposed. Therefore PATH3206, the T2 course had to run online for the second consecutive year. Overall, three time periods can be identified within the past 3 years depending on the strictness of COVID-19 related restrictions: (a) No restrictions—T1 and T2 of 2019, (b) relaxing restrictions—T2 of 2020 and T1 of 2021, and (c) increasing restrictions—T1 of 2020 and T2 of 2021. Each of these groups included one iteration of PATH3205 (run in T1) and PATH3206 (run in T2).

Despite the changes in mode of delivery (Supplementary Table 1), the content taught remained the same across 2019–2021 except for a minor change in PATH3205 (a practical class on inflammatory bowel disease was replaced with a practical class on COVID-19). The teaching staff also largely remained the same except one significant change for PATH3206 where a new convener took over in 2021. However, this did not affect the content or the structure of the course except for two lectures (delivered by the new convenor, without a change in learning objectives). The convenor for PATH3205 and co-conveners for both courses remained the same from 2019 to 2021.

Data analysis

The quantitative data (Q1–Q5) were analyzed in three ways: (a) comparisons within each course across different years (to note course specific trends in responses), (b) grouped into calendar year and compared across different years (to identify student cohort specific trends while adjusting for course specific trends), and (c) grouped according to the prevailing COVID restrictions. The comparisons were done as mean differences in feedback scores with statistical significance set at $p < 0.05$ (adjusted for multiple testing by Bonferroni correction). The qualitative comments were read to identify recurring themes, and these were grouped by (a) calendar year and (b) prevailing COVID restrictions (increasing vs. relaxing). The myExperience surveys are considered valid by UNSW Sydney if the response rate is $>25\%$. The same cut-off was used in this analysis to identify a valid and representative survey per course.

Results

A total of 287 student responses were recorded across 6 surveys for both courses during 2019–2021 (PATH3205: 134, PATH3206: 153). A summary of response rates and the scores for each question or “domain” (Q1–Q5) in the quantitative feedback

is given in Supplementary Table 2. The response rate in each survey ranged from 41.6% to 71.1%. The average scores for these questions in all surveys ranged from 4.4 to 5.5 (moderately agree to strongly agree), indicating an overall positive student experience in all iterations of both courses.

The pairwise comparisons of feedback scores in each domain (Q1–Q5) per course between years 2019, 2020 and 2021 mostly showed non-significant differences indicating that student satisfaction across the years were similar, despite differences in student cohorts (Table 2). However, a few significant differences were noted—for PATH3205, overall satisfaction with the course (Q1) was significantly less in 2021 compared to previous years, which was mainly due to dissatisfaction with a lack of feedback for assessment tasks (Q3). In contrast for PATH3206, student satisfaction was significantly better across Q2–Q4 in 2021, compared to either one or both previous years. However, this did not translate to an overall significantly better satisfaction with the course in 2021 (Q1).

When quantitative responses were combined for both courses and grouped by year, there were no statistically significant differences (except in one comparison for Q3) indicating that student cohorts were largely homogenous across the years in how they perceived each feedback domain (Table 3). However, when responses were regrouped according to prevailing COVID restrictions as described in the methods, some clear trends emerged (Table 3). Students assessed at times of increasing restrictions were always more satisfied than students assessed at times of relaxing restrictions, and these differences were statistically significant across all domains assessed (Q1–Q5). Students evaluated at times of increasing restrictions were always more satisfied across all domains assessed compared to times with no restrictions, and for one domain (Q4) this difference was significant. Students assessed at times of relaxing restrictions were always more dissatisfied across all domains assessed compared to times with no restrictions, and for two domains this difference was statistically significant (Q1 and Q3).

Comparing the performance of students objectively, all enrolled students passed both these courses in 2019, 2020 and 2021. The enrolments (a surrogate measure of course popularity) steadily increased for both courses from 2019 to 2021 by approximately 52% (Supplementary Table 2).

When recurring themes in the qualitative responses were grouped according to calendar year (Supplementary Table 3), the top three positive themes emerging in 2019 were satisfaction with the content taught (in lectures, practical classes, and tutorials), engaging teaching style of tutors and lecturers, and the positive experiences with the course assignments. In 2020, these themes changed, and the top positives were flexible schedule and time “saved” with online teaching, satisfaction with content taught and satisfaction with the quality of online tools used for teaching. In 2021, the top positives were the content taught, good organization of teaching activities and positive experiences with the assignment task. The top recurring themes for negative experiences in 2019 were being “overwhelmed” by the content taught, poor

TABLE 2 Mean differences of student feedback in all domains assessed, compared against each calendar year, per course.

Course	Comparison	Mean difference				
		Q1	Q2	Q3	Q4	Q5
PATH3205	2019 vs. 2020	0.08	-0.04	-0.24	-0.08	0.15
	2019 vs. 2021	-0.6*	-0.03	-0.89*	-0.34	-0.29
	2020 vs. 2021	-0.68*	-0.31	-0.66*	-0.26	-0.44
PATH3206	2019 vs. 2020	-0.14	-0.05	-0.46	-0.18	0.22
	2019 vs. 2021	0.15	0.29	0.44*	0.21	0.44*
	2020 vs. 2021	0.29	0.34*	0.9*	0.39*	0.23

*Statistically significant mean difference at Bonferroni adjusted p value < 0.017 . Feedback domains—Q1: overall satisfaction with the course, Q2: felt as being part of a learning community, Q3: feedback by teachers helped in learning, Q4: course resources helped in learning, Q5: assessments were appropriate.

TABLE 3 Comparisons of means in each feedback domain for both courses (PATH3205 and PATH3206), arranged according to calendar year and then regrouped according to prevailing COVID restrictions at the time of teaching.

Grouping method	Mean differences (MD)** and <i>p</i> values arranged by feedback domain									
	Q1		Q2		Q3		Q4		Q5	
Calendar year	MD	<i>p</i> value	MD	<i>p</i> value	MD	<i>p</i> value	MD	<i>p</i> value	MD	<i>p</i> value
2019 vs. 2020	-0.04	0.707	-0.11	0.359	-0.47	0.002*	-0.14	0.258	0.15	0.247
2019 vs. 2021	-0.17	0.132	-0.03	0.752	-0.21	0.101	-0.03	0.788	0.09	0.453
2020 vs. 2021	-0.13	0.321	0.07	0.515	0.26	0.095	0.11	0.391	-0.06	0.628
<i>COVID restrictions*</i>										
None vs. Relaxing	-0.33	0.006*	-0.22	0.04	-0.71	<0.001*	-0.25	0.048	-0.03	0.796
None vs. Increasing	0.14	0.171	0.12	0.291	0.11	0.313	0.11	0.318	0.29	0.01*
Relaxing vs. Increasing	0.47	<0.001*	0.34	0.003*	0.82	<0.001*	0.36	0.005*	0.33	<0.001*

*Statistically significant mean difference at Bonferroni adjusted *p* value <0.017,

**Raw data for MD calculations are given in [Supplementary Table 2](#). For a comparison of V1 vs. V2, MD is positive if V2 > V1, and vice versa.

*COVID restriction groupings – None: PATH3205_2019 and PATH3206_2019, Relaxing: PATH3206_2020 and PATH3205_2021, Increasing: PATH3205_2020 and PATH3206_2021, Feedback domains—Q1: overall satisfaction with the course, Q2: felt as being part of a learning community, Q3: feedback by teachers helped in learning, Q4: course resources helped in learning, Q5: assessments were appropriate.

organization of teaching activities and concerns with assessments. However, in 2020 (and in 2021) the top negative experiences changed to lack of motivation to study including difficulties in time management, lack of physical interaction with peers / teachers, in addition to being “overwhelmed” by the content taught.

Discussion

This analysis of student feedback for two third-year undergraduate Pathology courses in Bachelor of Medical Science / Science degree programs in an Australian University showed that student satisfaction and perceptions of the course were influenced by the prevailing COVID restrictions with more positive experiences being reported at times of increasing restrictions. On the contrary, there were mostly no significant differences across all domains when the calendar year was the grouping variable for comparisons indicating that content difference across the years did not have a major influence. Thus the original study hypothesis is accepted.

The variations in student perceptions for an undergraduate University course were traditionally thought to be influenced by the content taught and the styles of the teaching staff. However, the data presented here, shows that COVID related mobility restrictions may also be a significant influencer with more dissatisfaction being reported at times of relaxing restrictions (and vice versa). Importantly, this effect is independent from student responses to the change in teaching delivery (shift from face-to-face teaching to online) as there were mostly no significant differences in combined feedback scores for both courses in 2019 (F2F) vs. 2020 (online), or 2019 (F2F) vs. 2021 (online). This also suggests that the student cohorts in each year were largely homogenous in how they

perceived the courses. One possible explanation of this observation is that at times of increasing restrictions, students are more worried about other significant disruptions to their lives which results in better appreciation of an “online ready” course, that smoothly translates to an online delivery mode without added stress. On the contrary, at times of relaxed restrictions, with increased optimism and increased expectations of “normalcy,” the same “online ready” courses may be appreciated less given their emphasis on e-learning tasks versus F2F activities.

The qualitative comments provide an in-depth understanding as to how student perceptions changed when teaching shifted online in 2020. The most mentioned positive themes in 2019 such as interaction with teachers or enjoying assessment tasks, gave way to appreciation of time saved by not having to travel, and ease of interaction with online platforms in 2020. By 2021, not having to travel remained a top favorite of students, but the novelty and excitement of using online platforms seemed to have worn-off. Regarding the negatives, dissatisfaction with information overload, course structure, or assessment tasks reported in 2019 gave way to boredom with online learning, lack of F2F interactions with peers or teachers and technical issues with slow or unstable internet connections in 2020. Interestingly, the top reasons for dissatisfaction in 2021 was almost similar to that in 2019 (except the lack of F2F contact between peers and teachers), and it seemed that students had adjusted better to online learning (e.g., less reporting of boredom or technical issues). When the responses were rearranged and analyzed according to the prevailing COVID restriction groupings, there were no major differences in top recurring themes, and this leaves the significant differences observed in quantitative responses for the same comparison unexplained. This favors the theory that external factors such as COVID restrictions (which were not

asked about in the survey) likely influenced the quantitative feedback.

These observations, if they are a generalizable phenomenon, have several key implications for university teachers. Firstly, the teaching methods need to be adapted to prevailing circumstances and pursuing a fully online mode of teaching (for a course expected by students to be taught F2F) at times of relaxing restrictions may lead to student dissatisfaction. However, our experiences with hybrid classes were also not satisfactory as it was technically difficult to provide the same attention and teaching experience to students who were physically present versus online (Herbert et al., 2017). This sentiment was shared by students who evaluated these classes unfavorably in their comments during T1 of 2021, the only instance they were trialed. Alternatively, we attempted to provide fixed classes that taught F2F only and others that taught online only (students had the freedom to choose one option) in T2 of 2021 but this plan had to be abandoned due to the reimposing of COVID restrictions in response to an outbreak. Secondly, these findings do not imply that teachers should ignore unfavorable student feedback during the pandemic by attributing such feedback to uncontrollable external factors. We continued to make iterative changes to our course delivery in response to student concerns (e.g., adjusting group sizes, making online teaching more interactive, improved feedback for assessment tasks). However, it is wise to hold back on making major changes to course content and structure until after scrutinizing student feedback over several iterations and adjusting for confounders such as significant disturbances to the normal way of life. Thirdly, when significant external influences are likely to influence student perception of teaching, it is important to collect feedback data over many iterations using the same evaluation tool, preferably employing an independent party, and this will provide valid feedback for evidenced-based changes to teaching.

There are many studies assessing the impact of COVID on undergraduate education and student expectations, and a recurrent finding in these studies (from different countries), is that the perceived impact of the pandemic on education is likely to be secondary to external confounders such as socioeconomic status, lack of social interactions and mental health concerns (Aucejo et al., 2020; Son et al., 2020; Alghamdi, 2021). In the Australian context, a report from the Tertiary Education Quality and Standards Agency (TEQSA) published in November 2020, stated that University students in general appreciated the efforts by the teaching staff to move to a fully online teaching environment at short notice (Tertiary Education Quality and Standards Agency, 2020). Most students surveyed identified the flexibility to manage their own time, increased support from academic staff and flexibility of online assessments as positive aspects of online education. Similarly lack of engagement with teachers and peers, IT problems and issues with online assessments featured as things that did not work well. These findings resonate with ours and indicate that

these issues are common to the broader sector of Australian Higher education. It will be also interesting to see if our observations reported in this paper can be duplicated elsewhere. Since the myExperience survey does not capture or ask students about their personal circumstances we can only hypothesize about the types of hardships (e.g., fear of illness, loss of employment) imposed by COVID influencing their perception of the quality of education. However, the TEQSA survey specifically inquired into these aspects and found housing/home environment, job loss, financial concerns, social isolation, and mental health to be significant concerns raised by students in addition to matters related to course content (Tertiary Education Quality and Standards Agency, 2020). At the height of the pandemic and at times of increased restrictions these issues may be more concerning to students than the finer aspects of their university education, but as the restrictions ease and these concerns are resolved, the expectations and scrutiny on the quality of education may increase.

This study has several limitations. Regarding generalizability of findings, our analysis is limited to two courses in the same discipline in a single university. However, the similarities of these courses, also enabled combining them in groupings as mentioned above. Both these courses were strong in e-learning before the pandemic, and the results may be different for courses heavily dependent on hands-on practical classes and demonstrations. Comparing results of student feedback across different academic years have an intrinsic bias due to cohort specific effects. However, we controlled for this aspect by demonstrating no significant differences in student feedback in all domains (except for one comparison), when grouped and compared across calendar years. When different iterations of the same course are compared against one another, they are assumed to be identical, but in a real-world scenario it cannot be true as teachers are expected to make iterative changes based on student feedback. We implemented such changes, but these were not major changes since they did not trigger a mandatory review required at school and a faculty level for such changes. There was, however, one major change in teaching staff as mentioned above.

Conclusion

This comparison of student feedback for two third-year undergraduate Pathology courses in an Australian University between 2019 and 2021 demonstrated that students tend to perceive the quality of teaching significantly better at times of increasing COVID-related mobility restrictions compared to times with relaxing restrictions, even when there were no substantial changes in course content. Given the limitations in our data source, the reasons for this observation cannot be confirmed but this phenomenon needs to be explored further using a mixed method analysis, as it may help teachers

to better understand student expectations under these challenging circumstances.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Human Research Advisory Panel, UNSW Sydney (HC210664). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

CR conceptualized the study, analyzed the data, and wrote the first draft. Four authors are conveners of either PATH3205 (PP and CR) or PATH3206 (DS, CR, and CH) while ST has overall administrative responsibility for courses run by the Department of Pathology. All authors contributed to the article and approved the submitted version.

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Supplementary material

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