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Anatomical sciences at the University of Edinburgh: Initial experiences of teaching anatomy online

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ABSTRACT

Background: The growing use of online education tools, combined with an increasing demand for anatomical education from non-traditional student cohorts, prompted us to develop a postgraduate Anatomical Sciences degree programme. Taught entirely online, this programme of study allows students from anywhere in the world to study anatomy and related subjects at the University of Edinburgh. Here, the initial three years of programme delivery is described, including an examination of the student cohorts, their geographical location, their background on application and an exploration of qualitative feedback on their programme experience.

Methods: Data collected from the applications of student cohorts from academic year 2015/16 through to 2017/18 were anonymised and analysed to assess student personal characteristics. Also, qualitative student feedback data were obtained from evaluation questionnaires collected anonymously at the end of each course of the programme.

Results: The majority of the Anatomical Sciences students were female (72%) and within the age range 20–29. In addition, despite being accessible all over the world, the majority of the student cohort resided in the UK (50%). Qualitative feedback suggested that online teaching in anatomy was well-received and enjoyed, particularly in the form of video lectures and bespoke online resources. Challenges such as the modes of assessment and the lack of exposure to anatomical material were noted.

Conclusion: Investigating the backgrounds and opinions of the initial Anatomical Sciences students is a useful method to ensure a high level of delivery as the programme continues. Here, data and feedback for the first three years of the programme have been analysed and have highlighted specific challenges of teaching anatomy online. Finally, the future directions of online education within the anatomical sciences field is discussed.

1. Introduction

Anatomical Sciences at the University of Edinburgh is a new postgraduate programme leading to the award of a Postgraduate Certificate or Diploma, with additional possibilities for students to engage on a professional development basis. Prior to 2015, a very successful on-campus postgraduate Human Anatomy MSc programme had been established, focussed on extensive dissection-based teaching, as well as a large component dedicated to educational theory and practice. Despite the success of this on-campus programme, an increasing number of enquiries from prospective students wishing to undertake further study of anatomy were received. These students were not able to consider undertaking a full-time, on-campus MSc qualification for a variety of personal (e.g. geographical location, family commitments etc.) and professional reasons. At the same time, an increased demand for bespoke practical anatomy courses was identified for health and allied professionals, as well as biomedical and holistic practitioners, with respect to continuing professional development [1]. To address this, the unique challenge of developing a series of online courses was undertaken, providing postgraduate anatomical education to via a part-time study mode and whatever their geographical location.

Given that cadaver-based teaching methods are traditionally recognised and readily accepted approaches for anatomy education at both undergraduate and postgraduate levels [2,3], the first major challenge was to address how to deliver online postgraduate education within the anatomical sciences field. As the work of others has shown, the harnessing of technological innovations has shifted the fundamental orientation of face-to-face instruction to a more blended learning approach [4–6]. In common with most institutions, there was long-established use of a virtual leaning environment (VLE) to deliver a variety

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Table 1
Courses in the anatomical sciences programme.

Qualification	Course Name (credits)			
PG Certificate	Fundamentals of Human Anatomy 1 (20)	Fundamentals of Human Anatomy 2 (20)	Neuroanatomy (10)	Embryology (10)
PG Diploma	Advanced Human Anatomy 1 (20)	Advanced Human Anatomy 2 (20)	Medical Imaging and Anatomy (10)	Histology (10)

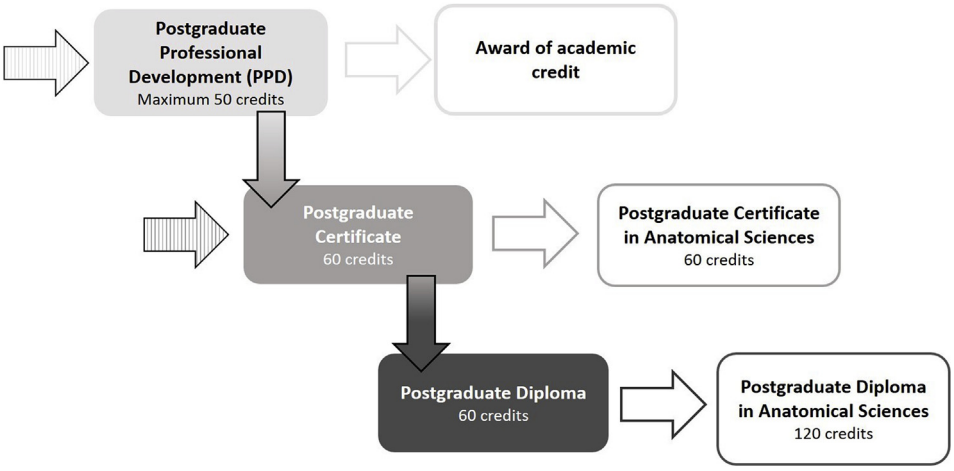

Fig. 1. Postgraduate student entry, exit and progression points for the Anatomical Sciences Programme. Up to 50 credits can be studied as part of Postgraduate Professional Development or a full Postgraduate Certificate (60 credits) can be taken. Successful completion of the Certificate can lead to enrolment on the Postgraduate Diploma, a further 60 credits to complete 120 credits in total.

of online resources within campus-based teaching programmes and other online programmes of study in different areas [7]. The VLE provides all users, including students, academics and administrators, with a central point of information delivery and interaction. By adopting this platform, the online delivery of teaching materials was facilitated using an existing tool within the University of Edinburgh and the Anatomical Sciences team were able to establish a series of online courses that provided a single point of contact for all users in the programme. To this end, the Anatomical Sciences programme was launched in 2015 and consists of a series of courses that students can complete to be awarded a Postgraduate Certificate or Diploma (Table 1; Fig. 1) or engage with courses individually as Postgraduate Professional Development (Fig. 1).

This study describes the development, and initial three years of delivery, of the Anatomical Sciences programme. We provide an overview of student numbers, geographical location and their educational background at the time of application. In addition, we explore the student perceptions and the specific challenges of enabling students to develop skills in anatomical sciences in an online environment.

2. Methods

The present study uses quantitative data retrieved from the University of Edinburgh's online application system (EUCLID) from successful candidates, incorporating information provided at the time of application. All data were anonymised, in line with established privacy policies, for cohorts of students from academic year 2015/16 through to 2017/18. Qualitative student feedback data were obtained from course evaluation questionnaires through the use of EvaSys software online survey platform for the same years. These were completed and collected anonymously at the end of each course and following programme completion. Data were collated and analysed using Microsoft Excel.

3. Results and discussion

3.1. Background personal characteristics of the anatomical sciences students

As a first stage of analysis, the backgrounds and personal characteristics for students on the online Anatomical Sciences programme, such as age, geographical location and educational background on application were evaluated. Information from a total of forty students was collated over academic sessions 2015–16, 2016–17 and 2017–18.

3.1.1. Age and gender

The age of students joining the Anatomical Sciences programme ranged from 21 to 66 on first application. The majority of students were aged between 20 and 29 (45%; n = 18, Fig. 2A). This was followed by 28% (n = 11) in the 30–39 age bracket (Fig. 2A). Student numbers in the 40–49, 50–59 and 60 + age categories were similar in numbers (10% (n = 4), 10% (n = 4) and 8% (n = 3) respectively, Fig. 2A). Of the 40 students analysed, 73% were female (29/40) and 27% were male (11/40) (Fig. 2B).

3.1.2. Geographical location

As a UK institution, there was significant interest in investigating how far-reaching the programme was, as the nature of online study enables learning with the University of Edinburgh regardless of geographical location. Exactly half of the students undertaking the Anatomical Sciences programme between 2015 and 2017 were based in the UK (50%; n = 20, Fig. 3). The remaining students were residing in mainland Europe (excluding the UK) (n = 6; 15%), North America (n = 5; 13%), Australia (n = 5; 13%) and Asia (n = 4; 10%) (Fig. 3). To date, no students from Africa or South America have participated in the programme.

3.1.3. Educational background on application

One major rationale for developing an Anatomical Sciences online programme was in response to the many individuals in the allied health professions that desired some formal anatomy education to complement their own career and/or professional development. It was therefore interesting to assess the backgrounds of students undertaking the

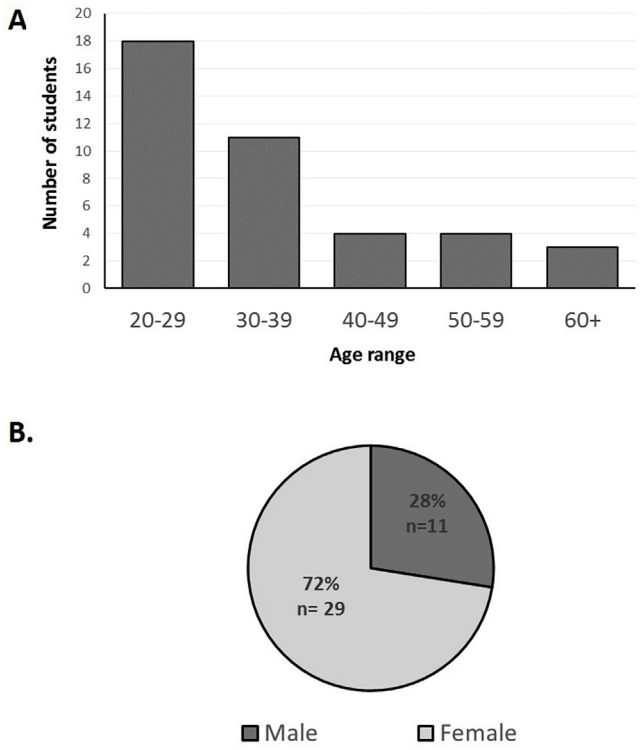

Fig. 2. Age (A) and gender (B) of Anatomical Sciences students from programme intakes 2015–2017.

programme during the time period 2015–2017. As anticipated, a notable proportion of students were from an allied heath background (n = 9; 23%, Fig. 4), and this was matched by those who already held an undergraduate medical or dental qualification (n = 9; 23%, Fig. 4). Students with backgrounds in a biology-related science (e.g. exercise science, human biology) were also represented (n = 7; 18%, Fig. 4) and those with a non-biology-related science qualification (e.g. forensic science) made up only 8% of the student cohorts (n = 3; Fig. 4). Most surprisingly, students with a background in the arts (eg. law, history, photography, dance and art) constituted the largest category of student backgrounds with 28% (n = 11) of students entering with an arts-related qualification (Fig. 4). This highlights an ever-increasing trend for anatomy education across the whole spectrum of the population and the potential far-reaching impact of online education.

3.2. Growth of the anatomical sciences programme

There has been a steady increase in student enrolment since launching the programme in academic year 2015/16. The initial intake comprised 10 students (Fig. 5A), all beginning with the compulsory Certificate year. The academic year 2016/17 saw an additional 10 students join into the Certificate year (Fig. 5A) with 5 continuing students entering the Diploma year (Fig. 5B), resulting in 15 students across the programme during the 2016/17 session. An increase in 2017/18 saw 16 new students joining the Certificate year of the programme (Fig. 5A), bringing overall programme numbers in 2017/18 to 28 across both programme years (Fig. 5B). Note that from 2017/18 onwards, the introduction of additional options for completing the programme in an intermittent study pattern or completing individual courses as part of Postgraduate Professional Development (PPD) study lead to a further increase in programme participants.

3.3. Course and programme development

With any new course and/or programme, student feedback is crucial to allow relevant and timely modifications to shape future development and implement improvements and/or innovations. For this reason, anonymised course evaluation surveys (facilitated by the EvaSys software) were sent to students following completion of each course and at programme completion. Levels of response varied amongst the student cohorts and individual courses from an 80% response rate in session 2015/16 (Fundamentals of Human Anatomy 1) to as low as 20% in one course in session 2016/17 (Advanced Human Anatomy 1). Nevertheless, qualitative assessment of feedback comments was undertaken, identifying several distinct themes. A summary of advantages and disadvantages of teaching anatomy online as suggested by the data analysed is presented in Table 2.

3.3.1. Course content

Overall, there was a very positive response to the course content, with many students remarking that they found the content "*valuable*", "*interesting*", "*engaging*" and of "*high quality*", with a good "*breadth of information covered*" and that the "*structured route through the subject made the learning process clear and manageable*". Students appeared to enjoy the format of the courses, which included a varied mix of text-based information, video lectures, workbooks and online quizzes.

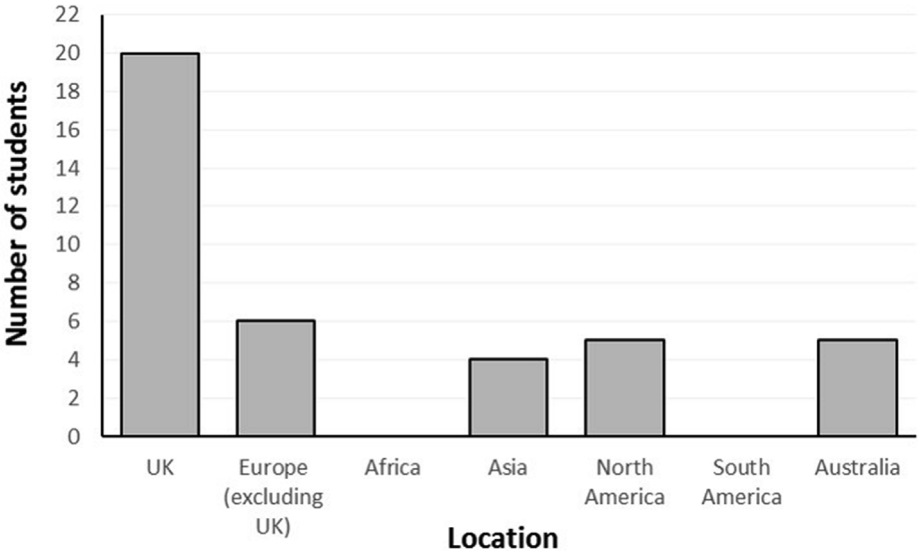

Fig. 3. Geographical location of study for Anatomical Sciences student intakes 2015–2017.

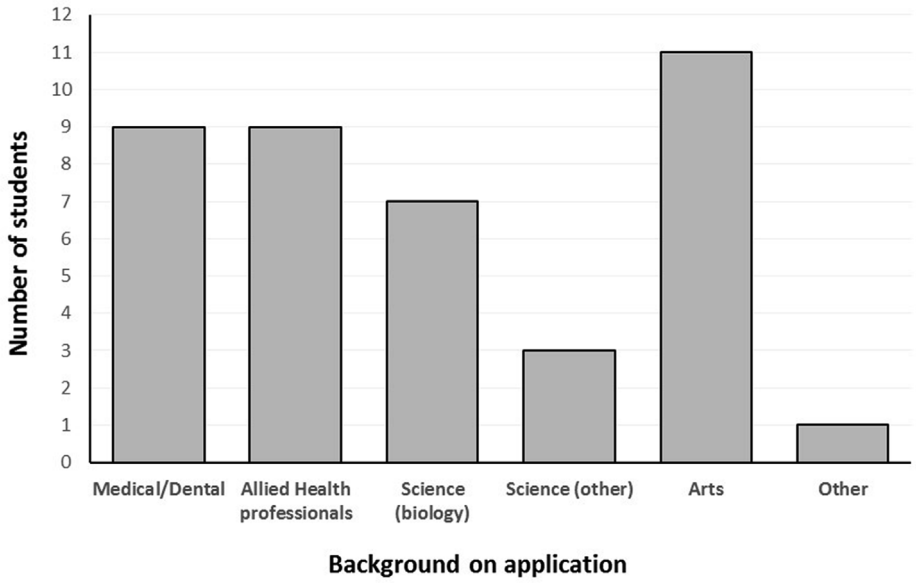

Fig. 4. Academic background of Anatomical Sciences student intakes 2015–2017.

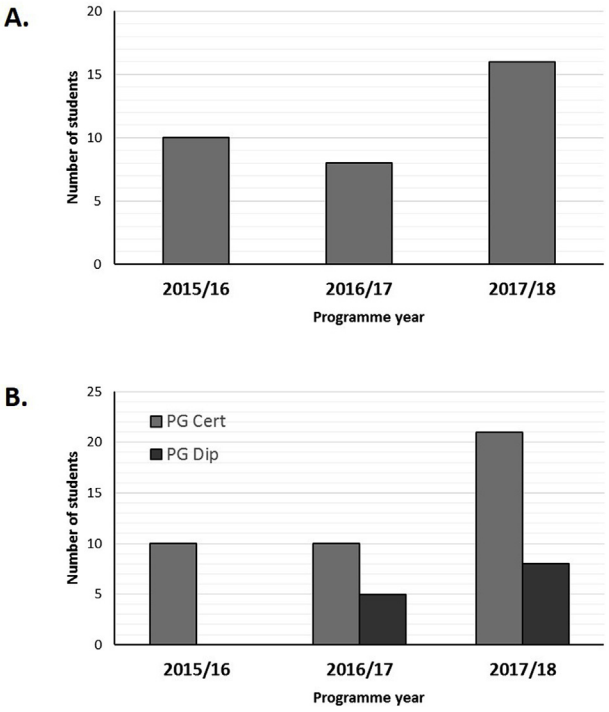

Fig. 5. Number of students on the Anatomical Sciences Programme from 2015–2017. A) Number of new entrants to the programme, beginning with PG Certificate courses. **B)** Number of students on the Anatomical Sciences programme during the session indicated. All students in 2015/16 began with PG Certificate level courses, thus no PG Diploma students' courses were running. In 2016/17, continuing students progressed to PG Diploma level while new students joined at PG Certificate level. Students can also exit after the Certificate year should they wish.

Indeed, the video lectures were praised as being "*very informative*" and it was highlighted that the ability to "*rewind and forward as you please*" was valuable. One particular student requested more of these, so it "*was more like being in a classroom*". In contrast, some students remarked that video lectures were a negative addition, since the "*audio was hard to hear*" and that they would "*have to go back over some sections four of five times*". On a similar theme, it was noted that if "*everything is going to be delivered by video lecture then there needs to be transcripts*", a valid point and an important improvement that is actively being integrated into the current and future video production, also to comply with accessibility requirements. Equally, it was stated that some students did not enjoy having to "*take notes on long lectures*" and others did not like the "*emphasis on lecture-based modules*", demonstrating a difference of opinion on the value of lecture-based recordings in online education. Indeed, the use of instructional videos and blended learning approaches have been trialled in anatomy and embryology teaching previously with mixed results [8–11]. Similar to this study, students did enjoy the ability to pause, rewind and view videos multiple times [9]. However, it has been suggested that the use of videos for online teaching is a passive form of teaching, and more interactive tools, albeit face-to-face or online would be of greater benefit [8]. Additionally, another study has suggested that the mode of information delivery actually has no bearing on the overall success of teaching and rather the level of student engagement is more important [10]. Interestingly, a small number of students remarked that they believed podcasts would be a worthy addition to some courses. Although an interesting method of disseminating information, it is difficult to see how best to implement this within such a visual subject such as anatomy but it remains a potential avenue to explore further within the programme.

Table 2
Advantages and disadvantages of teaching anatomy online.

Online learning in anatomy	
Advantages	Disadvantages
Variety of delivery methods	Lack of face-to-face contact with tutors
Video lectures/info can be viewed multiple times	Assessment practices
Use of cutting edge software/tools	Lack of physical exposure to cadaveric material
Flexibility	Potential for isolation if not engaged
Students can work at their own pace	
Can be structured to fit around existing commitments	
Collaborative working	
Peer support and networking	
No restriction on geographical location	

3.3.2. Programme/course organisation

A worthy point to note in the feedback about the format of online education was the ability of students to work at a time, location and speed that was best for them and their learning style. This was highlighted by feedback comments such as praise for the "*planning of the module, I was able to see what was required each week so I could fit it into my other commitments*", "*easy to fit around my full-time job*" and a further student commented that a valuable aspect of the online programme was that they could "*work at their own pace*". In this regard, a clear and structured course timetable and controllable release schedule appears to be the most appropriate method of delivering taught information in an online environment.

3.3.3. Formative assessment

Student responses suggested that a clear, positive addition to many courses was the addition of formative quizzes, that allowed the students to gauge their own understanding of the learning objectives during their time on the course. These were frequently mentioned as a valuable component of the courses, with students stating that the "*tests at the end of each section really good practice for the exam (sic.)*". In fact, it was noted that in courses where mini tests were not included, the students often wanted them, noting this as a potential improvement for future development of courses within the programme in feedback surveys. The educational advantage of using revision quizzes has been demonstrated in several previous studies [12–14], so it was expected that the inclusion of formative online quizzes would be a positive and useful feature to include in the online learning environment. The fact that these can be implemented and designed to give students instant feedback on their performance was considered to be particularly beneficial.

3.3.4. Workbook activities

Another interesting finding from the qualitative feedback was that students valued the inclusion of a 'Virtual Lab' activity for the gross anatomy components, which made use of images of cadaveric material in a workbook format that the students could work through systematically. The usefulness of these resources were regularly mentioned as a valuable addition to the teaching material (e.g. "*the pictures with labels were very helpful*" and "*I found it very helpful to see real life actual images rather than illustrations*"). In fact, the inclusion of "*more dissection images*" was highlighted as a point for improvement in some course evaluation reports. Initially, these workbooks were used as learning aids, for students to discover the correct answers using the lecture material, however, in response to student feedback, complete answer keys were provided at the end of each week/section of teaching material, giving students a complete set of images to compare to their own attempts. Likewise, courses without gross cadaveric material e.g. Histology and Embryology, provide a similar workbook activity with a periodic release of answers that the students used and appreciated, stating "*the histology workbooks – I felt that being able to work through these each week help me 'test' how well I had understood the lectures, and where I needed to do more work to understand something*".

3.3.5. Access to multiple resources

Many students emphasised the access to online anatomy resources (e.g. e-copies of multiple recommended course textbooks and Acland's Video Atlas of Human Anatomy) as a very positive addition to joining the programme. As part of the overall programme design all courses have an electronic resource list, allowing students to navigate directly from the learning environment to the resource of interest hosted in the University Library, enabling a seamless transition between environments. It is unknown whether the propensity to use the online resources were due to the addition of the accessible resource lists, or whether students would have consulted these anyway through the University Library route. Nevertheless, it is a feature that is well used and liked by students on the programme.

3.3.6. Collaborative working/discussion boards

Each course on the Anatomical Sciences programme has its own discussion board to encourage collaboration and discussion between students as peer support and/or with staff to help build a sense of community. Furthermore, the use of discussion boards has been suggested as a method to improve student learning of gross anatomy in a previous study [15]. The use of the discussion boards was notably varied between courses and indeed student cohorts. While some students in particular courses made use of the tools to discuss topics or ask questions, noting that "*the discussion board is a fast way of communicating with tutors and fellow students*", others were not keen to get involved in discussion, course-related or otherwise. In fact, feedback from the first course of the programme highlighted the lack of interaction, with comments such as "*I think more interaction between the tutors and the students or even within the students would make it more interesting and engaging*" and "*little interaction with others*" as points for improvement. In direct response to this, and as a further attempt to build a class/course community, a subsequent course in the Certificate year of the programme (Fundamentals of Human Anatomy 2), assessed student coursework via a group task, centred around the creation of an anatomical teaching resource or a WIKI ('What I Know Is') site. Built using the online learning environment tools, the WIKI task required collaborative input from several students in one group, to create a coherent submission and thus required a high level of communication and interaction between group members. Again, the level of engagement for this type of exercise was extremely mixed, with some students fully participating in the task while others failed to contribute to an acceptable standard.

Although the assessment procedure included an anonymised peer review feedback component, allowing for individual contributions to be managed and marks adjusted accordingly, many students did not value this method of assessment. Indeed, specific feedback points raised were that the task was "*challenging*" and that "*working with people all around the world made it difficult to fully discuss matters*". Also, they felt that it was made more difficult by "*not being able to work at your own pace by having to communicate so intensely with others who may have a different pace.*" Having run this assessment exercise several times between years 2015–2018, it appears that the success is largely dependent on the student cohort involved, their willingness to interact with others and that when all participants actively engage, excellent, high-quality submissions are definitely achievable. A similar approach was used previously in anatomy [16] and medical education [17,18] where the benefits of collaborative working, engagement and peer learning/support were highlighted amongst many others [18]. Interestingly though, Dungay & Gallagher [19] reported on the integration of a wiki task in Radiation Therapy education and highlighted a mixed response of students in terms of the overall perception of the usefulness or the task. This mirrored the responses received in this study, where not all students saw the benefit of working collaboratively or perhaps did not want to engage fully with the task.

3.4. Challenges of teaching anatomy online

3.4.1. Assessment methods

Whilst student feedback provides a powerful tool for gauging opinion concerning the content and delivery of courses, it is also important to highlight specific challenges of teaching anatomy online and particular advantages and disadvantages experienced by the academic team. A major challenge faced by teaching staff was how to ensure appropriate methods of examination. Indeed, this is a challenge faced by any online education course [20–23]. End of course assessments were deployed via an online testing platform, built into the Learning Environment. In order to detract from practices such as using notes and/or textbooks during the exams, exam papers consisting of a combination of multiple choice, extended matching, item/structure identification (similar to SPOT examinations) and short answer questions were released

for a very specific time period per student (e.g. 60 min). Although the timed nature of the exam was not popular with students, it was deemed the most appropriate method of delivering such an exercise. Ultimately, the biggest limitation faced when dealing with online education is the lack of face-to-face contact, and thus, control over the individual sitting the exam. We are currently investigating additional methods to ensure security and robust testing of the students on programme.

3.4.2. Lack of physical exposure to anatomical specimens

A further, and sizeable, challenge of teaching human anatomy online is the absence of tactile/experiential learning through dissection or handling of real anatomical specimens [24]. Indeed, to combat this, a range of additional online resources and activities were created to supplement students learning. Video lectures were created by members of the team to incorporate an auditory component and a personal element, allowing students to hear their tutors, putting a voice and identity to a name. To aid student's revision, virtual dissector workbooks, composed of questions and images, similar to workbooks given to on campus students were also included. Although these online resources do not involve tactile learning, they do incorporate active learning; the process of students engaging in an activity that forces them to reflect on ideas, along with encouraging students to regularly assess their own degree of understanding of the topic [25]. To incorporate active learning several of the virtual dissector workbooks were transformed into interactive Portable Document Format (iPDFs), which allow students to fill in their answers online through interactive textboxes and drop-down menus, without the need to print the document. Other active learning activities included the creation of a group WIKI, as previously discussed, individual presentations within the Neuroanatomy and Histology modules and formative revision tests at the end of each module. Incorporation of active learning resources has previously been shown to benefit students, particularly image-based methods [26] and, combined with the positive feedback received on such resources, there are clear benefits to creating and disseminating these resources to students. As a further notable point, the fully online nature of this programme does not permit the students to enter the dissection room in person and it is often strongly argued that dissection is vital for anatomical understanding [27]. Furthermore, it has been suggested that the act of dissection is not used simply as a preferred method of anatomy teaching in the medical and anatomical sciences curriculum [28] but that it also equips the students with other skills such as professionalism, team working, surgical skills and empathy [27,29] that are important in the medical curriculum. Although fully acknowledged, it is perhaps a key point to distinguish the true value of anatomical dissection in different areas of medical and/or related practice. For example, the importance of anatomical dissection is deemed of high value in medical and, in particular, surgical training [30] but may be of less value in our student cohort. Regardless, it remains to be evaluated if these students gain any further skills in additional to their anatomical knowledge through the participation in the online programme of study, but it will be an interesting comparison to make as the programme continues.

4. Conclusion

Here, a description of the successes and challenges of establishing and delivering a full academic postgraduate programme in Anatomical Sciences entirely through online learning methods has been presented. The importance of knowing the student population is highlighted and there is the acknowledgement that this is important to help drive innovation and direction as the programme grows. The flexibility and accessibility of this programme allows students to fit study around their existing work, opens anatomy education up to those with diverse and varied backgrounds, and facilitates learning from instructors and peers alike. In addition, several challenges in delivering anatomy education online have been highlighted and how the combination of technological advances and the long-standing enthusiasm for this subject is extremely well-placed to make a valid contribution to postgraduate anatomy education.

Ethical statement

Not applicable.

Financial disclosure

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Declaration of competing interest

The authors report no conflicts of interest.

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