Student performance in anatomy examinations depending on the modes of learning/teaching: onsite or online

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Abstract

Introduction: Traditionally, anatomy is a subject that involves a hands-on lab-based component using embalmed cadavers and histology slides. Due to the COVID-19 pandemic there were many changes to Sri Lankan medical education. This study analysed the effect on student performance in anatomy teaching/learning methods with the start of COVID-19 pandemic in a Sri Lankan medical faculty.

Methods: Three student groups with completely onsite (Batch A), transition to online midway through the semester (Batch B), and almost completely online (Batch C) were included. Their second-semester examination performance was analysed in total and component-wise [multiple-choice questions (MCQ), short-answer questions (SAQ) and objective-structured practical exams (OSPE I – Projections, OSPE II – Gross spot)]. Descriptive analysis, Kruskal-Wallis and Dwass-Steel-Critchlow-Fligner tests were used for comparison.

Results: Allocated proportions for MCQ:SAQ:OSPE were 30:40:30. Mean MCQ marks of batches A, B, C were 14.8, 14.9, 16.4 and mean SAQ marks were 24, 25.1, 24 respectively with significant differences in both [MCQ-H(2)=29.1, p=< .001, SAQ- H(2)=11.3, p=.003). With MCQs batch C had the best performance (p=< .001), whereas batch B had better performance than batch A (p< .001) in SAQs. Mean OSPE marks were 24.8, 17.4, 20.7 with a significant difference (H(2)=334.8, p=< .001). Batch B had lower performance than batch A and C(< .001), while batch A had performed better than batch C (.<.001) in OSPEs.

Conclusion: MCQ performance was better in online learners while OSPE performance, which reflects the understanding of the three dimensional structure was better in onsite learners. This highlights the value of receiving hands-on experience with cadavers and histology practicals.

Keywords: anatomy, medical education, online learning, onsite learning, cadaveric dissections
Introduction

Learning and teaching Anatomy cannot be accomplished solely through books. Since the beginning of medical education, teaching this basic science of medicine involved cadaver-based dissections to familiarise and get hands-on experience with the human body. (1) Across various techniques of teaching and learning, this physical and practical approach remains widely used even today, as a reliable method for studying normal and variant anatomy and understanding the three-dimensional structure and relationships of the human body. (2,3) This hands-on experience is either a whole-body dissection or faculty-guided demonstrations on prosected cadavers. Either way, they both have heavy in-person interactions. (1) However, due to the reduced availability of donated cadavers and the higher intake of students to the faculties, anatomy education with cadaver dissection has been greatly reduced. (4) With the advancement of technology and newer technical tools, the way of anatomy teaching and learning is constantly changing and we can find many medical schools that have replaced cadaver dissection with a digital experience partially or completely. (1) These newer tools (e.g., virtual models of the human body/virtual anatomy table, 3D printing, dissection software programmes) can aid the perception of knowledge from different viewpoints as well as facilitate understanding of the three-dimensional structure of the human body, although expensive. (3,4)

In the literature, six methods/techniques of anatomy education have been mentioned: in-person lectures, cadaveric dissection, inspection of prosected specimens, using models, living and radiological anatomy teaching, and computer-based learning that includes recorded lectures, videos, audio and anatomy software. (2,4) These can further be classified as onsite/face-to-face, blended, and online teaching models. In onsite education, students are present in a classroom/lecture hall/laboratory and experience learning on the site while a teacher/instructor teaches/guides them through the study materials. In online education, learning occurs via online platforms such as Moodle, Zoom, etc. Blended learning involves both onsite and online teaching/learning activities. (5)

General evaluation of anatomy knowledge is by several types of assessments: theory knowledge by written examinations based on multiple choice questions (MCQ)/single best answer type questions (SBA), short answer questions (SAQ), or essays while practical/clinical application of this core knowledge is tested by oral examination (VIVA), spot tests, objective structured practical examinations (OSPE), or objective structured clinical examinations (OSCE). (6) These evaluation domains are in line with the first and second tiers of Miller’s pyramid (first tier - knowledge tested by written exams and MCQs, second tier - application of knowledge assessed by essays, clinical problem-solving exercises and extended MCQs) that was introduced for the assessment of clinical competency by George Miller in 1990. (7)

Novel coronavirus or COVID-19 started as an outbreak in Wuhan City, China in December 2019 and soon spread into a worldwide pandemic to affect every socio-economic level and had a great impact on the education systems of the world. (8) Sri Lanka, as a low-middle income country faced many difficulties. The transformation caused by the COVID-19 pandemic across the globe affected almost all educational institutes including universities which rapidly converted to online delivery of education and assessments. The situation provided an opportunity to modify and design the future anatomy curriculum and its delivery (1,3) and this was the case for other subjects in Sri Lankan schools and universities.

Although several studies in Sri Lanka assess the student practices, perception and attitudes towards online learning, to the best of our knowledge student performance depending on the mode of learning has not been previously evaluated in the country. (9-11) The main objective of this study was to compare the total and differential marks obtained for different components of one module of the anatomy examination (MCQ, SAQ and OSPEs) among three batches that had different modes of teaching/learning methods as completely onsite (Batch A), transition to online mid semester (Batch B) and almost completely online (Batch C).

Methods

This was a descriptive cross-sectional study that involved the anatomy marks of three batches of first-year medical students at the same university in Sri Lanka. We used year 1 semester 2 examination marks that were held at the end of the thorax-abdomen module. The three batches were named Batch A (completely onsite learning before the pandemic), Batch B (transitioned to online learning mid-semester), and Batch C (completely online learning with two weeks of expedited onsite practicals).

The total population of the three batches that faced
the end-semester examination for the module on thorax and abdomen was included and the students who failed to face the examination were excluded. After applying inclusion and exclusion criteria Batch A had 205 students, Batch B had 204 students, and Batch C had 241 students.

Ethical approval was obtained from the Ethical Review Committee, Faculty of Medicine, University of Peradeniya (ERC no: 2023/EC/63). Statistical analysis was done with the Jamovi (version 2.3) Computer Software. Descriptive analysis included mean, standard deviation, and minimum and maximum values. Mean marks obtained by batches A, B, and C for components of MCQ, SAQ, and OSPE I and II including projections and cadaver-based spots were compared using the non-parametric Kruskal-Wallis test as the Shapiro-Wilks normality test was not fulfilled by each of the groups (p<0.05). The Dwass-Steel-Critchlow-Fligner (DSCF) test was used for the pairwise comparison of the groups.

Results

Proportions of marks allocated for MCQ:SAQ:OSPE in this module examination were 30:40:30. Mean MCQ marks were 14.8 (SD ±3.29), 14.9 (SD ±3.22), and 16.4 (SD ±4.19), mean SAQ marks were 24.0 (SD ±3.88), 25.1 (SD ±5.15), and 24.0 (SD ±5.56) and mean OSPE marks were 24.8 (SD ±3.18), 17.4 (SD ±3.05), and 20.7 (SD ±3.66) for batch A,B,C respectively. Mean total marks for batch A,B,C were 63.4 (SD ±8.95), 57.3 (SD ±9.96), and 61.0 (SD ±12) Full descriptive analysis of the marks is shown in table 1.

Detailed analysis for comparison of the different components of the examination using Kruskall-Wallis test and DSCF pairwise comparison of marks among three batches are shown in tables 2 and 3 respectively. Accordingly, the mean MCQ marks of batches A, B, C showed a significant difference (H(2)=29.1, p<.001), with batch C showing the best performance (p<.001), and batch B had better performance compared to batch A although statistically not significant (p=.886). Mean SAQ marks also showed a significant difference (H(2)=11.3, p=.003), and here batch B had better performance than batch A (p<.001) and batch C (p=.126). Mean OSPE marks also showed a significant difference (H(2)=334.8, p<.001), where batch B had significantly lower performance than batch A and C (<.001), while batch A had performed better than batch B and C (<.001).

Discussion

As mentioned earlier, anatomy education has evolved from full on-site teaching-learning domain to blended learning during the past few decades. This change accelerated with the effects of COVID-19 pandemic, including the temporary lockdown of countries as per government regulations and the implementation of policies on physical distancing. The closure of educational institutes in response to the pandemic led to the use of online modes which were adapted in Sri Lanka as well.(8-10) The teaching and learning process continued through online platforms including evaluation where applicable.

Challenges during COVID-19 pandemic faced by Sri Lankan universities

COVID-19 pandemic necessitated the conversion of universities in Sri Lanka to the online format of teaching/learning with the rest of the world. Traditional medical education in the medical faculties

Table 1 - Descriptive analysis of MCQ, SAQ, OSPE and total marks of three batches

<table>
<thead>
<tr>
<th></th>
<th>MCQ</th>
<th>SAQ</th>
<th>OSPE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>N</td>
<td>203</td>
<td>208</td>
<td>245</td>
<td>203</td>
</tr>
<tr>
<td>Mean</td>
<td>14.8</td>
<td>14.9</td>
<td>16.4</td>
<td>24.0</td>
</tr>
<tr>
<td>SD</td>
<td>3.29</td>
<td>3.22</td>
<td>4.19</td>
<td>3.88</td>
</tr>
<tr>
<td>Minimum</td>
<td>7.00</td>
<td>5.00</td>
<td>3.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>22.0</td>
<td>24.0</td>
<td>25.0</td>
<td>32.0</td>
</tr>
</tbody>
</table>

MCQ - multiple-choice questions, SAQ - short-answer questions, OSPE - objective-structured practical exams, N - number of students, SD - standard deviation
Table 2 - Kruskall-Wallis comparison of different components of the examination

<table>
<thead>
<tr>
<th>Component</th>
<th>$\chi^2$</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCQ</td>
<td>29.1</td>
<td>2</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>SAQ</td>
<td>11.3</td>
<td>2</td>
<td>0.003</td>
</tr>
<tr>
<td>OSPE</td>
<td>334.8</td>
<td>2</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Total</td>
<td>39.9</td>
<td>2</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

MCQ - multiple-choice questions, SAQ - short-answer questions, OSPE - objective-structured practical examinations

Table 3 - Dwass-Steel-Critchlow-Fligner pairwise comparison of marks among three batches

<table>
<thead>
<tr>
<th>Batch</th>
<th>MCQ (W, p)</th>
<th>SAQ (W, p)</th>
<th>OSPE (W, p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - B</td>
<td>0.664, .886</td>
<td>4.91, .001</td>
<td>-23.3, &lt; .001</td>
</tr>
<tr>
<td>A - C</td>
<td>6.636, &lt; .001</td>
<td>1.85, .389</td>
<td>-16.2, &lt; .001</td>
</tr>
<tr>
<td>B - C</td>
<td>6.345, &lt; .001</td>
<td>-2.75, .126</td>
<td>15.3, &lt; .001</td>
</tr>
</tbody>
</table>

MCQ - multiple-choice questions, SAQ - short-answer questions, OSPE - objective-structured practical examinations

in Sri Lanka was based on onsite teaching and learning that expanded over a 5 - 5½ years including clinical and skill based exposure at skill laboratories and teaching hospitals. This is more so with the subject of anatomy in the first 1½ years. Onsite learning and group work aid the students with their leadership qualities, skills, attitudes, teamwork and professional development in addition to core subject knowledge.(8)

With the conversion, the academic staff adapted to online education. The particular medical faculty where the current study was done, anatomy educators used online real time and recorded lectures, videos, 3D animations, and explanatory videos of prospected specimens to teach anatomy to the students. Traditional tutorials were transformed into online tutorials where the students and the lecturer discuss the basic anatomy and related clinical components of the questions. Educators switched to distant learning platforms such as Zoom, Learning Management Systems (LMS), Whatsapp groups, Google classroom and Moodle to connect with students and upload the learning materials.

Lower economic status, which aggravated during the COVID-19 pandemic, poor internet connectivity especially in certain geographical locations in the country, lack of access to devices, disruptions to the academic calendar, and lack of opportunities for professional development were problems that students of higher educational institutions in healthcare encountered faced during online learning. (8-11) Furthermore, regarding online anatomy learning during the pandemic, the lack of onsite practicals, diminished socialization and lack of self-motivation had a significant impact on medical students.(9)

The effect of this change on student performance in Sri Lankan universities has not been studied up to now. The unexpected but valuable experience obtained through the unavoidable shift to online methods of teaching/learning provides useful insights into the effective use of these modalities in the future.

Online medical education

Online education can be asynchronous; where the transmission and receipt of information do not coincide (e.g., pre-recorded lectures, videos), synchronous; where all learners receive information simultaneously and communicate directly with each other (e.g., teleconferencing, instant messaging, internet chat forums) or hybrid, where there is a mix of asynchronous and synchronous learning. An online hybrid curriculum can offer a rich learning experience as it incorporates the best features of both learning modalities.(1) An educational intervention conducted
using the online platforms, in the field of surgery involving 1st year medical undergraduates up to postgraduate trainees in Sri Lanka received favourable feedback from the students(10), proving that online mode could provide useful in medical education. However, studies on student perception on converting to online anatomy learning during the COVID-19 pandemic reveal that although the overall attitude towards online learning was positive, most believe online education cannot completely replace the onsite mode, particularly when it comes to practical and clinical based components.(3,9,12) It should also be noted that medical students face several problems during the use of e-learning modalities such as, barriers to free access of material, internet related expenses and connection issues, distractions while using online resources, and inadequacy of storage space in devices.(11)

Assessment modalities in anatomy education

The assessment of anatomy knowledge in medical education includes evaluating theoretical and practical aspects. For theory, assessment modalities include multiple-choice questions (MCQ), and short answer questions (SAQ). The practical component involves cadaver-based spots, objective structured practical examinations (OSPEs), and oral examinations.(6)

A systematic review evaluating academic performance on anatomy between online and face-to-face teaching revealed no statistical difference between the two teaching methods, although a higher level of student satisfaction with face-to-face teaching was observed.(2)

Selected module and examination

This study looks at the differences in the student performance in the anatomy module of thorax and abdomen among three groups of students; those who had completely onsite learning before the pandemic, the students who had transitioned to online learning midway through the semester, and those who had completely online learning with only two weeks of sped up onsite practical sessions. Regardless of the mode of conduct of the course, the examination in this particular module was held physically at the faculty premises. So the students had to complete all the components of the examination in a similar manner.

When we look at the results obtained by these three batches who did the learning part in three different modes, Batch C, which had completely online learning, had the best performance (p=<.001) when it comes to MCQs. When considering SAQ marks, batch B, which had a transition from onsite to online mode had better performance than batch A (p< .001). Batch A, that had completely onsite education had the best performance when considering the OSPE component (< .001) while batch B had significantly lower performance compared to batches A and C (< .001). The performance varies across the components of the examination. The OSPE component was best performed by those who did onsite teaching/learning activities. OSPEs are based on dissections and histology practicals. Those who had hands-on experience in the dissection room and practical classes did better with specimens at examinations. They have participated in small dissection group discussions, mock OSPEs, and bodyside tutorials during their dissection time which the complete online teaching/learning group has missed. On the other hand, MCQ performance was best among those who did online teaching/learning. Since they had very limited time with specimens, they may have invested greater time in studying books which must have aided with better performance in MCQs.

Similar to our study, Chang et al. in 2021, had evaluated student performance in lecture (theory) and laboratory (practical) components of anatomy examinations of two groups; one unaffected by COVID-19 and the other which faced the transition to modified learning during the pandemic. They showed a significant decrease in the performance in the laboratory component during the transition period compared to the unaffected group, although their performance had comparatively improved during the following examination.(13)

While not considering the different examination components, other studies on the comparison of onsite vs online anatomy education have shown a better student performance with online or hybrid education although their assessments were also conducted using online platforms in contrast to our study.(14,15) But in another study where students’ perceptions were recorded regarding their academic performance before (onsite teaching) and during (online teaching) the pandemic, the numbers indicated their grades being higher, same or lower were equal even though the method of assessment was not mentioned.(16)

A systematic review on the COVID-19 pandemic and its effects on anatomy education state that cadaver dissection extends beyond just learning the human morphology and involves the touches, incisions, hands-on-skills and complex 3D-dimensional
structure understanding which is rather difficult through only online resources.(3)

However, highlighting the importance of adapting to newer technology while following traditional methods, a randomised-controlled trial comparing remote and onsite learning/teaching have found that both onsite team teaching and well-prepared recorded video teaching (vodcast) promotes better learning among medical and nursing students effectively, according to the participants' test result analysis.(16,17)

Conclusions and recommendations

The best MCQ performance observed among those who had mostly online learning shows that the use of digital resources could benefit the students. However, as a subject like anatomy is mainly based on the understanding of the three-dimensional structure, the best performance in the OSPEs among those who had completely onsite learning, suggests that hands-on experience may help to understand the subject in further depth. Moving forward, the integration of online activities while continuing the onsite methods are likely to lead to the improvement of teaching and learning anatomy among university students.

Limitations

As this study was done using the marks available, we didn't analyse the other factors that may have affected the teaching/learning mode such as the quality of internet connection and availability of devices concerning Batch C and the number of students per dissection group in Batch A. The theory papers were scrutinised at the department and faculty level; however, difficulty indices were not calculated for each examination paper. The students were selected to the medical faculty based on their z-score at advanced level examination (bio science stream) and the cut off values lie within a more or less similar narrow range every year, but we didn't compare those values among the three student groups. These are the key drawbacks of this study.

Conflicts of interest

The authors declare that they have no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics approval

Ethics approval was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Peradeniya

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