Can Orthopedic Surgery be taught online? A comparative analysis of medical students’ academic performance in online versus in- person class teaching

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Research Article

Keywords: Education, Academic performance, Orthopedic, COVID-19, Medical, Online teaching

Posted Date: November 2nd, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2169946/v1

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Abstract

Objective

Due to controversy and the lack of information in the literature, we conducted this study to assess the impact of online teaching on students’ academic performance during the coronavirus (COVID-19) pandemic and evaluate whether the theoretical part of a surgical specialty, such as an orthopedic surgery, can be learned efficiently using online modalities.

Design

This is an observational study that compared the learning outcomes of medical students, in college of medicine at King Saud University, who took fully online orthopedic surgery courses into the learning outcomes of those who took similar courses in-person prior to the COVID-19 pandemic.

Participants

Grades of 530 fourth-year medical students were collected. Of the total participants, 321 (60.6%) were males and 209 (39.4%) were females. A total of 270 (50.9%) students attended in-person classes while 260 (49.1%) students attended online classes during the pandemic.

Results

For the online classes, the grades ranged between 20.5 and 40 with a median 32.6. Students who attended online classes had significantly higher grades than those who received in-person classes (32.4 ± 4.8 versus 30.2 ± 4.3, p < 0.001).

Conclusions

Our study showed that there has been significant improvement in the academic performance of students in online classes compared to in-person classes. Online teaching could be considered in orthopedic theoretical knowledge. Appropriate technical support and training for online classes for faculty and students should be established.

Introduction

During the coronavirus (COVID-19) pandemic, many countries implemented strong measures to reduce the spread of the disease which affected more than 231 million people worldwide. Some of these measures included social distancing and lockdowns.¹ These measures affected several domains,
including education. Educational institutes, such as universities, were closed and the mode of teaching shifted from in-person to online classes to ensure the safety and health of educators and students. Consequently, online teaching has become a mainstream method other than traditional teaching in several educational fields, including medicine.

Although online teaching is considered a cost-effective method and a solution for a lack of teaching staff, it requires a proper infrastructure for communication and internet technologies. Online teaching generally includes different e-learning platforms, virtual training, or video-conferencing. Despite established measures to assess the quality of online education (such as use of appropriate methods, course content, etc.), it could be challenging for some students because of limited non-verbal communication, limited interaction between students and professors, and lack of accessibility to required materials.

According to a study conducted in Germany, many medical students showed concern about the disadvantages of online teaching and were stressed that not all aspects of medical education could be digitized, such as bedside teaching and clinical examination. Online teaching also resulted in decreased academic performance compared to traditional teaching according to a study in the US, which was focusing on the effectiveness of distance education. Furthermore, another study showed that there was a low evaluation score for the level of knowledge gained in different education fields, such as clinical, natural sciences, or social humanities. It concluded that bedside teaching and clinical skills are more important to be acquired through traditional teaching compared to other sciences. Another study compared exam scores before and after introducing online teaching and showed that the average exam scores in some subjects were higher for in-person teaching than for the online teaching.

On the other hand, a study investigating the effect of online education on learning outcomes of medical students showed that there was a significant increase in the academic performance of students who had online courses compared to those who had in-person classes. This previous study showed that the students participations in the PBL session through online was better therefore they had better grades and assessment and the main reason for that is that online session gave them easier access to online resources and faster than face to face sessions. Gonzalez et al. found that students performed better in online classes during the COVID period compared to regular classes during the pre-COVID period in the same courses. This improvement in academic performance was attributed to the fact that students had more time and, therefore, studied more consistently. Subramanian et al. found that students who took online courses had higher test scores and better knowledge and skills compared to students who received regular teaching. A systematic review of 16 articles comparing online teaching to regular teaching in medical education identified that 7 articles reported no significant difference between these teaching methods while 9 articles reported a significant improvement in the academic scores of the online learning groups.
Owing to this controversy in the literature and a lack of studies that measure academic performance using quantitative measures, such as exam scores and student grades, we conducted our study to assess the impact of online teaching on students’ academic performance during the COVID-19 pandemic in particular and whether the theoretical part of a surgical specialty such as orthopedic surgery can be learned efficiently using online modalities. To this end, student grades before and during the pandemic were collected and compared.

Materials And Methods

Study Design

This is an observational study that compared the learning outcomes of fourth-year medical students, at King Saud University Medical School, who completed fully online orthopedic surgery courses, since the start of the pandemic in 2020, into the learning outcomes of those who took similar courses in-person prior to the COVID-19 pandemic.

Study participants

Grades of 530 fourth-year medical students were collected. Of the total participants, 321 (60.6%) were males and 209 (39.4%) were females. A total of 270 (50.9%) students attended in-person classes while 260 (49.1%) students attended online classes during the pandemic. The grades represented the students’ written exam scores using multiple-choice and short-answer question formats. Study materials and learning resources for both groups (online versus in-person classes) were similar. No changes were made to the course curriculum or the format and content of the lectures. The same instructors gave the same topics to both groups. Students in both groups took their test in person and the exam questions were framed according to a standardized course objective and were carefully and thoroughly reviewed by an assessment and evolution exam center to ensure that they represent the learning outcomes of the course. Students and faculty received proper training for online classes, including clear and comprehensive tutorials from the IT department on how to utilize the online platform optimally. Technical support staff were available online during the lectures to help with any issues and a fast internet connection was made available. There was a short answer quiz at the end of each session, whether taught in-person or online teaching. It was implemented to encourage the students to attend classes. There was no student drop outs in both compared courses. The difference in number of students enrolled in the course was not the result of any student dropout, but the normal year to year variation in medical student enrollment. The examination methodology was exactly the same between the two groups. Students had experiences written exams which was face to face in both groups and also had Objective Structured Clinical Examination (OSCE) in both groups, so both studying platforms had the same exam experience, both of them had their exams face to face.

Data Analysis
Data were entered into Microsoft Excel (Version 16.12; Microsoft, Redmond, CA) spreadsheets and then analyzed using SPSS (Version 22.0. IBM Corp., Armonk, NY). Data were presented as frequencies and percentages for categorical data and mean and standard deviation for continuous data.

Learning methods and gender were presented as frequencies and percentages while grades were presented as means and standard deviations. Grades were compared by learning methods or gender for both using t-test or Mann–Whitney test, as appropriate. All P-values were two-tailed and P < 0.05 was considered as significant.

**Results**

Figure 1 shows the grade distribution of students by learning methods. For in-person classes, the grades ranged between 16 and 40 with a median 30.9. For the online classes, the grades ranged between 20.5 and 40 with a median 32.6.

As shown in Table 1, students who attended online classes had significantly higher grades than those who received in-person classes (32.4 ± 4.8 versus 30.2 ± 4.3, p < 0.001). For male students, those who attended online classes had significantly higher grades than those who received regular learning (31.5 ± 4.8 versus 30.2 ± 4.5, p = 0.015). Similarly for female students, those who took online classes had significantly higher grades than those who attended in-person classes (33.7 ± 4.5 versus 30.1 ± 3.8, p < 0.001). However, irrespective of the learning methods, female students had significantly higher grades than male students (31.9 ± 4.5 versus 30.8 ± 4.7, p = 0.009).

As shown in Fig. 2, the difference in grades between the two methods was 3.61 (95% confidence 2.47–4.74) in females and 1.27 (95% confidence 0.25–2.29) in males. Additionally, the variability in grades was higher in male students than in female students, as evidenced by the wider interquartile range.

**Discussion**

A new era in medical education emerged during the challenging period of the pandemic. Online teaching became mainstream for numerous educational fields, including medical education. Many educational institutes also considered online exams as part of COVID-19 precautions. Online education offered several advantages, especially the possibility to learn anytime and anywhere. Kim JW et al. found that online classes are generally favored and provide more interactive discussions compared to in-person classes. Additionally, a systematic review conducted by George et al. showed that online teaching yielded equivalent results in terms of knowledge and skills gained and student satisfaction. Another study conducted in Italy, which compared online and in-person classes for physiotherapy, showed that there was no difference in student's satisfaction levels between the two methods, but online classes yielded higher performance grades compared to in-person teaching. However, a study in Korea that looked at the academic performance of students in 19 different courses found that the average test scores decreased for most online courses. Various reasons were suggested for this decline, such as the
sudden transition to online classes, the fact that most of the faculty did not have proper training for online classes, and the lack of technical support. Moreover, another study showed that even though students had more time to study when courses were delivered online, the majority of them preferred traditional teaching for better understanding of the course materials and topics.

Our study showed that there was a significant improvement in students’ academic performance in online classes compared to in-person classes. The results indicated that when proper technical support was provided for faculty and students, online teaching could also be considered for orthopedic surgery. Although our study did not measure competency in terms of clinical and surgical skills among medical students and mainly focused on the didactic aspect of learning orthopedic surgery knowledge, it has multiple strengths, including the standardized course learning materials and study aids, uniform course format and content, and same faculty and lectures for both groups. We believed that having a readily available online technical team and receiving appropriate online teaching prior to class, to ensure a better understanding and optimal use of the online platform, was crucial for students; it assured a smooth transition to online learning and helped them achieve their learning goals. In addition, taking a quiz in the form of short-answer questions at the end of each class had a positive impact on students’ attendance and engagement in both group.

Conclusions

Online teaching has become necessary in many educational institutes because of its cost and time efficiency, given the right technical support. Our study showed that there has been a significant improvement in the academic performance of students in online classes compared to in-person classes. It also showed that given the proper technical support, online teaching could be considered for orthopedic surgery courses. Therefore, proper technical support for the faculty and students should be established. Future studies may focus on the possibility of using advanced online teaching modalities, such as virtual reality technology for clinical and clerkship activities.

Declarations

Ethics and consent to participate

Ethics approval and informed consent was waived by the Institutional Review Board (IRB) in King Saud University - IRB Project No. E-22-6915.

All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not Applicable.

Availability of data and material
All data is available upon request. For inquiries (Ahmed F. Alfaleh - a.alfaleh90@gmail.com)

**Competing interests**

No competing interests.

**Funding**

No funding was needed.

**Author contributions**

The authors testify that all persons designated as authors qualify for authorship and have checked the article for plagiarism. If plagiarism is detected, all authors will be held equally responsible and will bear the sanctions imposed by the journal thereafter.

**Waleed Albishi:** Supervising the review of literature,

**Hisham Alsanawi:** final report and manuscript writing.

**Ahmed F. Alfaleh:** Drafting and manuscript writing and Submission

**Hamza Alrabai:** Drafting and manuscript writing

**Abdulrahman Alaseem:** Drafting and manuscript writing

**Acknowledgements**

Not applicable

**References**


### Table 1

Grades of orthopedic surgery classes in the fourth-year medical students by learning methods and gender

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<thead>
<tr>
<th></th>
<th>Number</th>
<th>Frequency</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>P-value</th>
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<tr>
<td>Regular</td>
<td>270</td>
<td>50.9%</td>
<td>30.2</td>
<td>4.3</td>
<td>&lt;0.001</td>
<td>M-W</td>
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<td>Zoom</td>
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<td>49.1%</td>
<td>32.4</td>
<td>4.8</td>
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<tr>
<td>Total</td>
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<td>100.0%</td>
<td>31.3</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
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<td></td>
<td></td>
<td></td>
<td>0.009</td>
<td>M-W</td>
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<tr>
<td>Male</td>
<td>321</td>
<td>60.6%</td>
<td>30.8</td>
<td>4.7</td>
<td></td>
<td></td>
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<tr>
<td>Female</td>
<td>209</td>
<td>39.4%</td>
<td>31.9</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>530</td>
<td>100.0%</td>
<td>31.3</td>
<td>4.7</td>
<td></td>
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<tr>
<td><strong>Learning methods in males</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Regular</td>
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<td>52.3%</td>
<td>30.2</td>
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<tr>
<td>Zoom</td>
<td>153</td>
<td>47.7%</td>
<td>31.5</td>
<td>4.8</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>321</td>
<td>100.0%</td>
<td>30.8</td>
<td>4.7</td>
<td></td>
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<tr>
<td><strong>Learning methods in females</strong></td>
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<td>3.8</td>
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<td>107</td>
<td>51.2%</td>
<td>33.7</td>
<td>4.5</td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
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<td>100.0%</td>
<td>31.9</td>
<td>4.5</td>
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</tbody>
</table>

M-W, Mann-Whitney test

### Figures
Figure 1

Distribution of grades of orthopedic surgery classes in the fourth-year medical students by learning methods (N=530)
Figure 2

Grades of orthopedic surgery classes in of the fourth-year medical students by learning methods and gender