INTRODUCTION

The dental anatomy and manipulation module is fundamental within undergraduate dental education and is strongly related to clinical competency (Bakr et al., 2017; de Azevedo et al., 2018). Principally, the module consists of two consecutive phases. The theoretical phase is delivered in the format of lectures, which comprise a slideshow presentation supported with illustrative videos and a verbal description of the relevant tooth morphology. This constitutes the core for understanding the anatomical and morphological

RESEARCH REPORT

Effectiveness of screen-to-screen and face-to-face learning modalities in dental anatomy module during Covid-19 pandemic

Sevcan Kurtulmus-Yilmaz | Özay Önöral

Department of Prosthodontics, Faculty of Dentistry, Near East University, Nicosia, Mersin 10, Turkey

Correspondence
Dr. Sevcan Kurtulmus-Yilmaz, Department of Prosthodontics, Faculty of Dentistry, Near East University, 99138 Nicosia, Northern Cyprus, Turkey. Email: sevcankurtulmusyilmaz@gmail.com

Abstract

The Covid-19 pandemic has forced all dentistry faculties to quickly shift to the online supplementation or replacement of traditional modules to pursue education. However, there is limited research evaluating the effectiveness of this education modality on student performance in dental anatomy and manipulation module. Accordingly, it was aimed to compare the influence of different education modalities on the performances of the students enrolled in this module. The students were requested to perform 11 practical assignments throughout the fall term. A total of 220 face-to-face-educated (F2F) and 138 screen-to-screen-educated (S2S) students were included. To evaluate the influence of education modality on the performances of the students, cumulative success scores were calculated and compared using an independent t-test. The grades of the first (maxillary central), sixth (maxillary premolar), and eleventh assignments (mandibular first molar) were also analyzed to understand the manipulation-skill progress of each student within the same year. The grades of above-mentioned three assignments were converted into nominal data (excellent, very good, good, acceptable, and fail) based on certain thresholds, and a chi-square test was conducted. The cumulative success scores in F2F group were significantly lower than those in S2S group ($P = 0.02$). Differences between the first and eleventh tasks in both education modalities were significant ($P < 0.05$). The S2S-educated students achieved significantly higher achievement points in the sixth and eleventh assignments ($P < 0.001$). The S2S education can be suggested as an applicable modality for teaching dental anatomy and manipulation module. However, further work is needed to ascertain whether this result is replicable throughout dental anatomy education.

KEYWORDS
Covid-19, dental anatomy practical module, dental education, distance learning, online learning, screen-to-screen education
characteristics of human permanent and primary dentition. In the subsequent practical phase, namely manipulation, a face-to-face (F2F) demonstration is conducted and subsequently, students are allowed to work individually in the pre-clinic and ask for help when it is necessary. This allows dental students to put their acquired theoretical knowledge into practice and thereby develop their essentials for operative dentistry including psychomotor skills, manual dexterity, cognitive ingenuity, and three-dimensional thinking (Obrez et al., 2011; Kellesarian, 2018; Conte et al., 2021). Carving of the permanent teeth by using soap or wax after their corresponding theoretical session is the most common way of teaching (de Azevedo et al., 2015) and is accepted as a golden standard (Patil et al., 2015).

The emergence of the Covid-19 (severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]) pandemic has globally caused deteriorations in the health, economic, and education sectors. Governments necessitated social distancing, restricted movements, and even introduced national lockdown which all brought new challenges to dental education (Önöral & Kurtulmus-Yilmaz, 2020). This is because the transmission route of Covid-19 to humans was declared to be via airborne droplets, saliva, blood-borne droplets, body secretions, touching, handshaking, close contact with an infected person as well as virus-contaminated surfaces (Barabari & Moharamzadeh, 2020; Izzetti et al., 2020; Meng et al., 2020; Hung et al., 2021). Tele dentistry has made a significant contribution to the combat against the Covid-19 as it allows remote dental care, guidance, education, or treatment with the aid of information technology rather than through F2F contact with any patient (Ghai, 2020).

Institutions seem preoccupied with finding the best way to educate when physically isolated from their students. Although screen-to-screen (S2S) education has been previously reported as a valid modality (Olmsted, 2014; Ludwig et al., 2016; Santos et al., 2016), it was not widely accepted in dental education as it is an undergraduate program where practical training predominates. However, the pandemic circumstances have forced all dentistry faculties to quickly transcribe the academic curriculum according to the S2S education modality in order to continue the delivery of curricula. Additionally, both educators and students had to cultivate their digital skills and quickly adapt to Google Meet (Google, LLC, Mountain View, CA), Zoom (Zoom Video Communications, Inc., San Jose, CA), Microsoft Teams (Microsoft Corp., Redmond, WA), and similar video-conference platforms (Deery, 2020; Smith & Pawlina, 2021).

Dental education extends on three prominent pillars: (1) theoretical modules, (2) preclinical practical modules, and (3) clinical training/internship (Chang et al., 2021). During the pandemic, to circumvent the issues influencing the first pillar, synchronized S2S theoretical modules were held in the vast number of dental faculties with the aid of different video conferencing tools (Bennardo et al., 2020; Machado et al., 2020; Önöral & Kurtulmus-Yilmaz, 2020; Wu et al., 2020) as it was proved that in the synchronized S2S modality, students have the opportunity to get live, real-time, facilitated, and learning-oriented education in an electronic classroom through active questioning or interaction with the lecturer (Shahabadi & Uplane, 2015). However, the detriments on the second and third pillars are more devastating. Many countries suspended simulation laboratory modules and internships as students must gather in the laboratory and hospital environments that pose a high risk in terms of virus spread and transmission in accordance with the inherent characteristics of dental settings (Balaji, 2020; Hung et al., 2021). Although some remedial steps have been taken such as sharing demonstration videos for practical modules (Chang et al., 2021); the internships could not be totally replaced with S2S activities (Bennardo et al., 2020). Problem-based learning tutorials, imaginary case reports, S2S discussions on clinical matters, teledentistry, videotaping were adopted for the 4th- and 5th-year dental students to refrain from the aggregation of individuals (Meng et al., 2020; Hung et al., 2021). Despite all these efforts, self-learning has gained great importance during the pandemic. Therefore, the students should be encouraged to engage in self-learning and to fully use online sources. Moreover, they should be psychologically supported against disease-associated fear, pressure to do well, and financial stress (Meng et al., 2020; Hung et al., 2021).

In North Cyprus, within the precautions of the pandemic and consistent with the decision of the higher education council, all courses have been conducted online since the spring semester of the 2019–2020 academic year. Considering this measure, the newly registered students to dentistry faculty in the 2020–2021 academic year took the dental anatomy and manipulation module in a completely S2S manner. These students attended S2S live theoretical lectures, watched asynchronous and synchronous demonstration videos which were shared with them via the online platform of Distance Education and Information Technologies Center (UZEBIM, 2021), and attended the S2S live practical courses with their instructors on Google Meet. Following each practical course, students acquired photographs of their assignments from different aspects under appropriate illumination and uploaded them onto the UZEBIM center for evaluation.

This center, UZEBIM, uses Moodle as a learning management system (Moodle Pty Ltd, West Perth, WA, Australia) and aims to follow all kinds of contemporary and up-to-date innovations in the field of educational technology to prepare permanent professional educational courses using green screen technology. It has eight main academic service areas mainly including distance education, e-exam, information technologies, academic component, electronic document management, etc. Students can access lecture notes, synchronized/asynchronized lecture videos, and all other documents whenever they want. In addition, classes can be created on this platform; students can be contacted, announcements can be made, assignments can be given, assignments can be evaluated, and comments can be made, e-exams containing a wide variety of question types can be performed. Above all, it works successfully with different software that ensures exam security.

Given the sparse number of studies investigating the influence of education modality on the performances of the students enrolled in the dental anatomy and manipulation module, this study aimed to compare the F2F and S2S education modalities in terms of student
performance and manipulation progress. The following hypotheses were tested: (1) F2F-educated students would have higher cumulative success scores than S2S-educated students, (2) F2F-educated students would have higher grades in specific assignments, and (3) the progression of manipulation skills would be seen in both education modalities.

**MATERIALS AND METHODS**

The current study was conducted on the data of the dental anatomy and manipulation module which is given to first-year dental students at the Near East University Faculty of Dentistry. Grades of the students who did not reject to be a part of this study were included. Therefore, the manipulation assignment grades of 220 F2F-educated students in the 2019–2020 academic year and 138 S2S-educated students in the 2020–2021 academic year were scrutinized. The demographics of the student population are depicted in Table 1.

**Dental anatomy module description**

At the Near East University, the dental anatomy and manipulation module consist of two theoretical committees (one fall term, one spring term) and a practical committee which is an annual course. During the 28-week academic year, one hour of theoretical and four hours of practical classes are held per week. The textbook *Wheeler's Dental Anatomy, Physiology, and Occlusion* (Nelson, 2015) is followed in theoretical courses. In practical courses, real-size or enlarged 3D artificial tooth models are used.

For the fall term, the anatomy and morphological characteristics of permanent dentition are elucidated within the scope of the theoretical committee and the students are requested to carve enlarged models of the permanent teeth from the soap in the practical committee. For the spring term, different dental materials such as gypsum products, dental wax, and acrylic resin are introduced within the context of the theoretical committee, and it is aimed to broaden the material science knowledge. In the light of acquired knowledge on material science, students are requested to perform gypsum carving, wax carving, and acrylic resin flaking (the process of investing the tooth carved from a wax block into a flask to form a sectional mold that is used to produce the relevant tooth from the acrylic resin) procedures in the practical committee.

To evaluate the performance of the students for this module, both practical and theoretical examinations are held on. In theoretical committee examinations, summative exams are performed by using a wide range of question types such as essay-type, fill-in-the-blank, or multiple-choice questions. In the practical examinations, within a limited time, students are requested to perform a practical assignment that has been previously done in the pre-clinic. A success grade is obtained by summing up three components: (1) the overall score of assignments performed throughout the year, (2) the overall score of the practical quizzes, and (3) the score of the end-of-year practical examination.

**Study design and participants**

For the F2F-educated group (2019–2020), every week before the practical session, a theoretical session was done instructing the anatomy of each permanent tooth in detail. In the practical session, students watched the F2F demonstration of soap carving at the pre-clinic and were directed to perform carving. After a week of practice, students were subsequently asked to submit the relevant soap-carving assignment.

For the S2S-educated group (2020–2021), the dental anatomy module was conducted in a completely S2S manner. The same curriculum in the previous year was followed. The UZEBIM center was effectively used during the pandemic period. Students attended the synchronous online lectures on Google Meet and the recorded video of the lecture was uploaded and kept on the UZEBIM center for being persistently reachable to re-watch. An asynchronous soap-carving demonstration video was also uploaded to the UZEBIM center before the practical session and an interactive live demonstration was performed on Google Meet every week at the beginning of the session which was also uploaded on UZEBIM center network. Students were divided into small groups (12 students maximum in each group) and invited to Google Meet links for the S2S practical session. The students were asked to turn on their cameras and practice soap carving under the observation of instructors. Throughout that week, students were allowed to consult. After a week of practice, students were asked to submit the photographs of their assignments onto UZEBIM center. Students were asked to follow the guideline for image acquisition and preparation to obtain standardization in assignments (Figure 1).

The evaluation of the practical assignments was made by the same lecturers according to the same criteria (Table 2) out of 100. The

| Education modality     | Total participants n (%) | Female n (%) | Male n (%) | Average age years (±SD) |
|------------------------|--------------------------|--------------|------------|-------------------------|
| Face-to-face           | 220 (61.5)               | 106 (48.2)   | 114 (51.8) | 19.2 (±1.7)             |
| Screen-to-screen       | 138 (38.5)               | 75 (54.3)    | 63 (45.7)  | 18.6 (±1.9)             |
| Total                  | 338 (100.0)              | 181 (100.0)  | 177 (100.0)| 18.9 (±1.7)             |
following grading boundaries were used in the consideration of the
grades: ≤49 fail; 50–64 acceptable; 65–74 good; 75–84 very good;
and ≥85 excellent (Bakr et al., 2016a). Figure 2 presents three differ-
ent assignments for mandibular first molar graded as excellent, good,
and fail. To achieve standardization, in both academic years, the the-
oretical lectures of the permanent teeth were given by the same lec-
turers. Data of a total of 11 tasks, including maxillary and mandibular
central and lateral teeth, maxillary canine, maxillary and mandibular
premolar teeth, maxillary and mandibular first molars, were obtained.

Statistical analyses

The grades of each student for each assignment were obtained for
both education modalities. Student scores from the dental anatomy
module were entered into MS Excel and imported into SPSS statisti-
cal package, version 23 (IBM Corp., Armonk, NY) for analysis. The
values of P < 0.05 were accepted as statistically significant.

Three different assignments were determined to analyze the im-
provement of manipulation skills and manual dexterity within each

| Anterior teeth                                      | Posterior teeth                                  |
|----------------------------------------------------|--------------------------------------------------|
| Criteria                                           | Points                                           | Criteria                                           | Points |
| Differentiating right-left teeth, general aspect,  | 30                                               | Differentiating right-left teeth, general aspect,  | 25     |
| polishing                                          |                                                   | polishing                                         |        |
| Crown/root ratio                                   | 5                                                | Crown/root ratio                                  | 5      |
| Mesiodistal/labiolingual dimensional ratio         | 5                                                | Mesiodistal/labiolingual dimensional ratio        | 5      |
| Edge lengths                                       | 5                                                | Edge lengths                                      | 5      |
| The transition from crown to root                 | 5                                                | The transition from crown to root                | 5      |
| Root morphology                                    | 10                                               | Root morphology                                   | 10     |
| Cervical line curvatures                           | 5                                                | Cervical line curvatures                          | 5      |
| The inclination of the labial aspect               | 5                                                | The inclination of the buccal aspect              | 5      |
| Triangular fossae                                  | 5                                                | Triangular and central fossae                     | 5      |
| Ridges (labial, lingual)                          | 5                                                | Ridges (buccal, lingual)                         | 5      |
| Developmental grooves                              | 5                                                | Developmental grooves                             | 5      |
| Cingulum morphology                                | 5                                                | Cusp dimensions                                  | 10     |
| Dimensional harmony of teeth with each other       | 10                                               | Cusp heights                                      | 10     |
| Total points                                       | 100                                              | Total points                                      | 100    |
For this purpose, the first (maxillary central), the middle-sixth (maxillary first premolar), and the last-eleventh (mandibular first molar) were selected. The supposition of normal distribution was confirmed with the aid of the Kolmogorov-Smirnov test. The data of these tasks were analyzed with a one-way analysis of variance (ANOVA) test and subsequently with Tukey HSD post hoc test for pair-wise comparisons.

To compare the effects of F2F and S2S learning modalities on the performances of the students; grades of first, middle, and the last assignments were analyzed with the independent t-test. Total scores of all assignments were also calculated for each student to obtain a cumulative success score. To evaluate the effect of education modality on general achievement, the cumulative success scores were compared with the independent t-test.

In the above-mentioned three assignments, the grades of the students were converted into nominal data (excellent, very good, good, acceptable, and fail) based on the rubric with thresholds. Subsequently, by cross tabulating the education model and the status of achievement, with the aid of the chi-square test, an additional analysis was conducted. The averages of the scores obtained by each student in the F2F and S2S modalities from 11 assignments were also calculated. The average achievement score obtained for each student were converted into nominal data (excellent, very good, good, acceptable, and fail) based on certain thresholds. Subsequently, the chi-square test was used for cross tabulating the education model and the status of average achievement.

Kendall’s tau B and Cronbach’s alpha were estimated to assess the validity and internal consistency (reliability) of the rubric scale (excellent, very good, good, acceptable, and fail).

**RESULTS**

The grading instruments used in this study were tested in terms of reliability. They represented reasonable reliability as Kendall’s tau B ranged from 0.70 to 0.92 and Cronbach’s alpha was 0.93. The mean grades of the students’ assignments and their standard deviations are demonstrated in Table 3. The mean grades ranged between 47.75 ± 14.16 and 56.80 ± 14.92 for the F2F group and 48.61 ± 16.60 and 61.63 ± 14.56 for the S2S group.

The enhancement in manual dexterity was evaluated by comparing the grades of first, middle, and last tasks within each education modality. For F2F and S2S education mediums, the manipulation skill was detected to be improved by means of exercise and training throughout the academic year. Although no significant differences were found between maxillary central and maxillary first premolar tasks in both F2F (P = 0.293) and S2S (P = 0.093) education modalities; the grades of mandibular first molar tasks were significantly higher than maxillary central tasks in both F2F (P = 0.014) and S2S (P = 0.001) education modalities. While the grades of maxillary first premolar were significantly lower than those of mandibular first molars in the F2F-educated group (P = 0.001); no statistically significant
difference was found between the grades of two tasks in the S2S-educated group ($P = 0.098$).

The medium of instruction was found to be effective on the achievement of the students enrolled in the dental anatomy and manipulation module. When the grades of the first, middle and last tasks were compared in terms of education modality, no difference was observed in the maxillary central task ($P = 0.813$); whereas the students who received the S2S dental anatomy practical course got significantly higher grades in the maxillary premolar ($P = 0.001$) and mandibular first molar tasks ($P = 0.001$). The cumulative success scores of eleven tasks were also analyzed to compare education modalities and the statistical analysis showed that the overall scores of the students in the F2F education modality (571 ± 100.15/1100) were significantly lower than the scores of the students (605 ± 136.20/1100) in the S2S education modality ($P = 0.02$) (Table 3).

Overall, it was found that the education modality has mainly influenced the percentage of high-achieving students. For the maxillary central assignment, 36.3% and 43.5% of the students received “fail” grade enrolled in F2F and S2S courses, respectively, and no statistically significant difference was found between education models ($P = 0.3198$). However, a significantly higher percentage (7.2%) of students received the ‘excellent’ grade who took the course in the S2S modality ($P = 0.001$). Significantly lower percentages in ‘fail’ grades were detected for the S2S-educated students for both maxillary first premolar ($P = 0.0008$) and mandibular first molar ($P = 0.0431$). Significant differences were also found in the ‘very good’ grade of maxillary first premolar ($P = 0.0125$) and mandibular first molar ($P = 0.0418$) at which percentages of S2S-educated students were higher. When the mean grades of 11 assignments for each student were evaluated according to the grading boundaries, a higher percentage of students got “fail” grades in the F2F education model ($P = 0.0293$). The percentages of students who got “excellent” (2.9%), ‘very good’ (34%), and ‘good’ (37%) grades were higher while only a significant difference was obtained for ‘very good’ grades ($P = 0.0009$) (Table 4).

### DISCUSSION

This research assessed the influence of education modalities on the performances of the students in the dental anatomy and manipulation practical module. The cumulative success scores and the grades of specific tasks were compared for both education modalities and improvement of manipulation skill was evaluated within each education model. The results indicated that the students in the S2S group achieved significantly higher cumulative scores, therefore the first hypothesis of the study was rejected. Intergroup comparison revealed that there were no significant differences between the grades of the first tasks, and significantly higher grades were detected in the S2S group for the other tasks. Consequently, the second hypothesis was also rejected. There were significant differences between the grades of the first and the last tasks for both education modalities as the grades increased toward the last task which confirms the acceptance of the third hypothesis.

The rigid challenge posed by the Covid-19 pandemic forced dental faculties to embrace S2S teaching (Wang et al., 2021). The S2S learning in dentistry during the pandemic have been previously discussed (Alzahrani et al., 2020; Iyer et al., 2020; Mukhtar et al., 2020; Önöral & Kurtulmus-Yilmaz, 2020; Schlenz et al., 2020) and its flexibility was reported as the principal advantage. In this mode of delivery, students can pause, rewind, and review courses at their

### TABLE 3 Performances of students for different assessment tasks in F2F and S2S modalities

| Task/education medium   | Score Mean (±SD) | Score [range] | Score Mean (±SD) | Score [range] | P-values |
|------------------------|------------------|--------------|------------------|--------------|----------|
| Maxillary central      | 51.9 (±14.14)A   | [18–87]      | 52.6 (±16.41)A   | [16–90]      | 0.813    |
| Maxillary lateral      | 50.7 (±14.21)    | [17–84]      | 51.99 (±17.34)   | [21–89]      |          |
| Mandibular central     | 50.05 (±15.65)   | [22–83]      | 49.89 (±15.52)   | [24–86]      |          |
| Mandibular lateral     | 53.72 (±15.72)   | [21–88]      | 52.21 (±11.62)   | [27–92]      |          |
| Maxillary canine       | 56.8 (±14.92)    | [33–94]      | 52.71 (±16.88)   | [37–91]      |          |
| Maxillary first premolar| 52.73 (±13.80)A | [22–89]      | 60.9 (±16.00)A,B | [32–92]      | 0.001*   |
| Maxillary second premolar| 50.61 (±13.11)  | [24–90]      | 53.89 (±16.51)   | [36–96]      |          |
| Mandibular first premolar| 51.56 (±11.42)  | [38–91]      | 61.5 (±21.13)    | [41–87]      |          |
| Mandibular second premolar| 51.44 (±11.37)  | [36–90]      | 59.28 (±21.38)   | [40–89]      |          |
| Maxillary first molar  | 47.75 (±14.16)   | [27–86]      | 48.61 (±16.60)   | [37–91]      |          |
| Mandibular first molar | 54.21 (±14.20)B | [26–92]      | 61.63 (±14.56)B  | [28–94]      | 0.001*   |
| Cumulative success score| 571.00 (±100.15)| [297–962]    | 605.00 (±136.20) | [357–983]    | 0.020*   |

Note: Number of participants in the face-to-face group ($n = 220$) and in the screen-to-screen group ($n = 138$). $P$-values indicate the statistical differences between two groups in the same row. Same superscript capital letters in the same column indicate no significant differences ($P > 0.05$) within the same education medium.

* $P < 0.05$. 

KURTULMUS-YILMAZ And ÖnÖRAL
own pace without time limit and physical boundaries of classrooms (Mukhtar et al., 2020; Önal & Kurtulmus-Yilmaz, 2020; Schlenz et al., 2020; Wang et al., 2021). In the present study, the percentages of high achieving (excellent, very good grades) and average (good) students educated with S2S manner were considerably higher than those of the F2F-educated group, whereas the percentage of failed students was significantly lower. This may be attributed to the above-mentioned advantages of S2S learning especially for the group of students that are more interested in and willing to the course. However, this finding is not in accordance with those of studies by Schlenz et al. (2020) and Yang et al. (2020). Yang et al reported that despite having a high number of participants, S2S live lectures showed low learning progress with a low completion rate. Schlenz et al. (2020) evaluated the perspectives of students and lecturers on S2S learning and concluded that students thought they were not prepared enough for the practical courses by participating only in S2S learning.

As the pandemic has continued, newly registered students in the dentistry faculty had to take the dental anatomy module in a completely S2S manner. Both academic and administrative members had concerns about the performance of newly registered students in the dental anatomy practical module as the students would not be able to examine 3D anatomy models used in the demonstrations and it was their first year in the dentistry faculty. However, the findings of this study revealed that students who got a fully S2S dental anatomy module showed significantly higher success scores. This result may be attributed to the accessibility of course materials. Different from previous years, this year, video records of live dental anatomy theoretical sessions, soap-carving demonstrations, and photographs of the carvings were uploaded onto the UZEBIM. In this manner, students were able to monitor course materials consistently. The use of recorded lectures in dental education has been suggested to serve as a supplement to enhance the learning capability of the students (Horvath et al., 2013; Kalludi et al., 2015). Receiving detailed feedback on their assignments may be suggested as another explanation for the higher performance of students in the S2S learning group. During grading the assignments on the distance learning platform, the lecturers and students had an opportunity to give and receive feedback. It has been reported that regular two-way feedback increased motivation and improved self-efficacy (Wang & Wu, 2008).

In the F2F education group, students have submitted their assignments to lecturers and lecturers evaluated them visually and three-dimensionally. However, in the S2S learning group, the assignments were graded by evaluating the photographs taken by the students and submitted to the distance learning platform. The latter method has some limitations which may result in higher or lower scores. Firstly, although students were asked to take photographs from different aspects and a guideline for submission was shared for each task; evaluation of two-dimensional photographs on a screen, the angle of photographs, and lighting conditions under which the images were captured may all affect the accurate evaluation. Besides, students had a chance to edit the photographs before submission which cannot be detected by the lecturer and result in

| Grade/range | Maxillary central | Maxillary first premolar | Mandibular first molar | Cumulative |
|-------------|------------------|-------------------------|-----------------------|------------|
| F2F (%)     | S2S (%)          | P-value                 | F2F (%)               | S2S (%)    | P-value |
| Excellent (≥85%) | 0.9 | 0.001* | 0.9 | 0.001* | 1.8 |
| Very good (75%–84%) | 5.5 | 0.017* | 12.4 | 0.001* | 22.2 |
| Good (65%–74%) | 16.8 | 0.017* | 20.3 | 0.001* | 34.7 |
| Acceptable (50%–64%) | 35.5 | 40.5 | 0.081 | 5.5 | 0.017* |
| Fail (≤49%) | 36.3 | 36.3 | 0.017* | 36.3 | 0.017* |
| Total grade | 100.0 | 100.0 | 1.000 | 100.0 | 1.000 |

Note: Number of participants in the face-to-face group (n = 220) and in the screen-to-screen group (n = 138).

Table 4: Students’ grades for three predetermined assignments in each group.
higher grades. To circumvent all these limitations, a video record of the task which makes the evaluation stage more accurate was requested from students to support the photographs. This approach was also implemented in the practical examinations and all alterations made on the task by the student were detected.

Current undergraduate dental students are part of generation Z which is also called the generation of digital natives since the members were born into a digital era and can adapt to technology easily. Generation Z students do not prefer traditional didactic teaching methods or listen to lectures for a long time and have higher demands for technology-based learning (Eaton et al., 2008; Reynolds et al., 2008; Dalmolin et al., 2018; Eckleberry-Hunt et al., 2018). A recent study (Abdalla, 2020) concluded that the use of digital technology in dental anatomy teaching was highly appreciated and rated by dental students.

This pandemic experience led the faculties to reconsider their dental curricula (Iyer et al., 2020). Traditionally, the learning model consists of 2D illustrations (clinical photographs, radiographs, or schematic drawings) on which the lecturer elucidates the morphology of the dentition. However, it is cumbersome, passive-learning, and inconvenient to acquire the learning content and morphological details. With this regard, real 3D models obtained from polystyrene or calcium sulfate can be regarded as beneficial at the pre-clinic. However, these models are not home portable. (Juan et al., 2016). Similarly, cadaveric teaching for human anatomy is commonly preferred. However, manifold problems such as an insufficient number of cadavers in comparison to the number of students or difficulties in conserving cadavers (Zafar & Zachar, 2020). To circumvent all these drawbacks, innovative approaches such as virtual reality (VR) and augmented reality (AR) have been introduced to contemporary dental education. Accelerated learning outcomes have been achieved with these innovations (Zafar & Zachar, 2020). Supportively, Juan et al. (2016) highlighted that augmented reality is completely intuitive and facilitates the study of dentition at home without the demand for a real 3D model. Another study suggested that the integration of AR technology provides an additional means of dental anatomy training. However, the same study also states that it cannot replace traditional cadaver education but will only serve as a supplement to traditional mode. Moro et al. (2017) recommended the use of VR and AR technologies as means to supplement course content in anatomy education. Reymus et al. (2020) investigated the effectiveness of VR technology in teaching root canal anatomy and concluded that third-year undergraduate students greatly appreciated VR simulation. Bakr et al. (2013, 2015) underlined another innovative modality in which computer-driven haptic-based dental simulators are used. These simulators present a vast number of advantageous properties including safety, ethical advantage, error management, the relevance of training, and enhanced precision as the tactile sensation is integrated into them. In the light of these data, it can be said that although students enjoy learning with these innovative tools; it is uncertain whether they present superior results in terms of knowledge acquisition.

Blended learning is a student-centered pedagogical approach that combines F2F and S2S learning modalities (Bakr et al., 2016a; Ma et al., 2019). Investigations on blended learning have sorely increased over the past decade for a better understanding of its applicability and sustainability in dentistry. Although Bennardo et al. (2020) emphasized blended learning as a cornerstone of future dental education and Bakr et al. (2016b) supported hybrid or blended model as a future of anatomy education; an ongoing controversy exists. Some of the researchers argue that traditional F2F education will completely replace S2S mode soon; however, some argue that the blended education model, in which S2S education acts as a complement, will be more dominant. Recently, flipped classroom, also known as an inverted classroom, has come to the fore as a subcategory of blended education and as an instructional strategy by which didactic information is given before class and the class-time is used as a dynamic interactive learning environment with the aid of mutual discussion (Bakr et al., 2016a; Day, 2018). It has been drastically evaluated in the literature for dental anatomy modules and found to improve student performance by increasing the engagement and motivation of students (Bakr et al., 2016a; Chutinan et al., 2018; Kellesarian, 2018). Supportively, another study documented that lower-performing students can benefit more from the flipped classroom than the higher-performing students (Day, 2018). Instead of being purely S2S education, the future curriculum of dental anatomy modules may include flipped or blended learning to better accommodate generation Z and enhance learning by shifting it toward the active contribution of students and improving student-lecturer interaction.

Limitations of the study

In the current study, students were not asked to evaluate the S2S education quantitatively or qualitatively or compare the F2F and S2S modalities which may be regarded as a limitation. The student satisfaction level may be the subject of future studies. Additionally, this study is limited to one dentistry faculty. A greater number of participants from a wider cohort of students would better reflect the consequences.

CONCLUSIONS

The inherent characteristics (aerosol involvement, gathering in pre-clinic, simulation laboratory, or clinics, F2F interaction with patients) of dental settings can pose potential risk factors in terms of Covid-19 transmission. Therefore, this pandemic has forced a vast number of dentistry faculties to quickly shift to S2S teaching, with the aid of all innovative techniques facilitating lecturer-student interaction. In this study, the effectiveness of S2S and F2F learning modalities in the dental anatomy module was scrutinized and the S2S education was suggested as an applicable modality for teaching
dental anatomy and manipulation module. However, to reinforce this finding, future studies are strongly needed as purely S2S education was not widely accepted in dental education wherein practical training predominates. In accordance with the futuristic approach, the blended or hybrid mode which amalgamates the advantageous properties of S2S mode (virtual reality, augmented reality, haptic simulation) with F2F mode will be accepted as optimal.

ACKNOWLEDGMENTS
This research was presented as an oral presentation at the 1st International Dental Education Congress in Ankara, Turkey (11-15 January 2021).

ETHICAL CONSIDERATIONS
The current study received ethical approval from the Near East University Scientific Research Ethic Evaluation Board with a reference number of YDÜ/EB/2021/650.

ORCID
Sevcan Kurtulmus-Yilmaz https://orcid.org/0000-0001-8792-1977

REFERENCES
Abdalla R. 2020. Teaching dental anatomy & morphology: An updated clinical- & digital-based learning module. Eur J Dent Educ 24:650–659.
Alzahrani SB, Alrusayes AA, Aldossary MS. 2020. Impact of COVID-19 pandemic on dental education, and students. Int J Health Sci Res 10:207–212.
Bakr MM, Massey WL, Alexander H. 2013. Evaluation of Simodont® haptic 3D virtual reality dental training simulator. Int J Dent Clin 5:1–6.
Bakr MM, Massey WL, Alexander H. 2015. Can virtual simulators replace traditional preclinical teaching methods: A students’ perspective? Int J Dent Oral Health 2. https://doi.org/10.16966/2378-7090.149.
Bakr MM, Massey WL, Massa HM. 2016a. Flipping a dental anatomy course: A retrospective study over four years. Educ Res Int 2016:7097398.
Bakr MM, Massey WL, Massa HM. 2016b. Digital cadavers: Online 2D learning resources enhance student learning in practical head and neck anatomy within dental programs. Educ Res Int 2016:8506251.
Bakr MM, Thompson CM, Massaqd M. 2017. Anatomical sciences: A foundation for a solid learning experience in dental technology and dental prosthetics. Anat Sci Educ 10:395–404.
Balaji SM. 2020. COVID-19-Future of dentistry. Indian J Dent Res 31:167–168.
Barbieri P, Moharamzadeh K. 2020. Novel coronavirus (COVID-19) and dentistry—A comprehensive review of literature. Dent J (Basel) 8:53.
Bennardo F, Buffone C, Fortunato L, Giudice A. 2020. COVID-19 is a challenge for dental education—A commentary. Eur J Dent Educ 24:822–824.
Chang TY, Hong G, Paganeli C, Phanthumvanit P, Chang WJ, Shieh YS, Hsu ML. 2021. Innovation of dental education during COVID-19 pandemic. J Dent Educ 16:5–20.
Chutinan S, Riedy CA, Park SE. 2018. Student performance in a flipped classroom dental anatomy course. Eur J Dent Educ 22:343–349.
Conte DB, Zancanaro M, Guollo A, Schneider LR, Lund RG, Rodrigues-Junior SA. 2021. Educational interventions to improve dental anatomy carving ability of dental students: A systematic review. Anat Sci Educ 14:99–109.
Dalmolin AC, Mckeivicz GA, Pochapski MT, Pilatti GL, Santos FA. 2018. Learning styles preferences and e-learning experience of undergraduate dental students. Rev Odontol UNESP 47:175–182.
Day LJ. 2018. A gross anatomy flipped classroom effects performance, retention, and higher-level thinking in lower performing students. Anat Sci Educ 11:565–574.
de Azevedo RA, Correa MB, Torriani MA, Lund RG. 2018. Optimizing quality of dental carving by preclinical dental students through anatomy theory reinforcement. Anat Sci Educ 11:377–384.
de Azevedo RA, da Rosa WL, da Silva AF, Correa MB, Torriani MA, Lund RG. 2015. Comparative effectiveness of dental anatomy carving pedagogy: A systematic review. J Dent Educ 79:914–921.
Deery C. 2020. The COVID-19 pandemic: Implications for dental education. Evid Based Dent 21:46–47.
Eaton KA, Reynolds PA, Grayden SK, Wilson NH. 2008. A vision of dental education in the third millennium. Br Dent J 205:261–271.
Eckleberry-Hunt J, Lick D, Hunt R. 2018. Is medical education ready for Generation Z? J Grad Med Educ 10:378–381.
Ghai S. 2020. Teledentistry during COVID-19 pandemic. Diabetes Metab Syndr 14:933–935.
Horvath Z, O’Donnell JA, Johnson LA, Karimbux NY, Shuler CF, Spalke H. 2013. Use of lecture recordings in dental education: Assessment of status quo and recommendations. J Dent Educ 77:1431–1442.
Hung M, Licari FW, Hon ES, Lauren E, Su S, Birmingham WC, Wadsworth LL, Lassetter JH, Graff TC, Harman W, Carroll WB, Lipsky MS. 2021. In an era of uncertainty: Impact of COVID-19 on dental education. J Dent Educ 85:148–156.
Iyer P, Aziz K, Ojcius DM. 2020. Impact of COVID-19 on dental education in the United States. J Dent Educ 84:718–722.
Izzetti R, Nisi M, Gabriele M, Graziani F. 2020. COVID-19 transmission in dental practice: Brief review of preventive measures in Italy. J Dent Res 99:1030–1038.
Juan M, Alexandrescu L, Folguera F, García I. 2016. A mobile augmented reality system for the learning of dental morphology. Digit Educ Rev 30:234–247.
Kalludi S, Punja D, Rao R, Dhar M. 2015. Is video podcast supplementation as a learning aid beneficial to dental students? J Clin Diagn Res 9:CC04–CC07.
Kellesarian SV. 2018. Flipping the dental anatomy classroom. Dent J (Basel) 6:23.
Ludwig B, Bister D, Schott TC, Lisson JA, Hourfar J. 2016. Assessment of two e-learning methods teaching undergraduate students cephalometry in orthodontics. Eur J Dent Educ 20:20–25.
Ma J, Li C, Liang HN. 2019. Enhancing students’ blended learning experience through embedding metaliteracy. Educ Res Int 2019:6791058.
Machado RA, Bonan PR, Perez DE, Martelli Júnior H. 2020. COVID-19 pandemic and the impact on dental education: Discussing current and future perspectives. Braz Oral Res 34:e083.
Meng L, Hua F, Bian Z. 2020. Coronavirus disease 2019 (COVID-19): Emerging and future challenges for dental and oral medicine. J Dent Res 99:481–487.
Moro C, Strombergza Z, Raikos A, Stirling A. 2017. The effectiveness of virtual and augmented reality in health sciences and medical anatomy. Anat Sci Educ 10:549–559.
Mukhtar K, Javed K, Arooj M, Sethi A. 2020. Advantages, limitations and recommendations for online learning during COVID-19 pandemic era. Pak J Med Sci 36:527–531.
Nelson SJ. 2015. Wheeler’s Dental Anatomy, Physiology and Occlusion. 10th Ed. St. Louis, MO: Elsevier/Sounders. 392 p.
Oberz A, Briggs C, Buckman J, Goldstein L, Lamb C, Knight WG. 2011. Teaching clinically relevant dental anatomy in the dental curriculum: Description and assessment of an innovative module. J Dent Educ 75:797–804.
Olmsestedt JL. 2014. Direct assessment as a measure of institutional effectiveness in a dental hygiene distance education program. J Dent Educ 78:1460–1467.
Önöral Ö, Kurtulmus-Yilmaz S. 2020. Influence of COVID-19 pandemic on dental education in Cyprus: Preclinical and clinical implications with e-learning strategies. Adv Educ 16:69–77.
AUTHOR BIOGRAPHIES

Sevcan Kurtulmus-Yilmaz, D.D.S., Ph.D., is a professor and teaching fellow in the Department of Prosthodontics, Faculty of Dentistry at the Near East University in Nicosia, Northern Cyprus. She is also the vice dean of the faculty. She is teaching dental anatomy and prosthodontics and her research interests are dentistry education, manual dexterity, information technology, esthetic dentistry, and material science.

Özay Önöral, D.D.S., Ph.D., is an associate professor and teaching fellow in the Department of Prosthodontics, Faculty of Dentistry at the Near East University in Nicosia, Northern Cyprus. He is also the vice dean of the faculty. He is teaching dental anatomy and prosthodontics and his research interests are dentistry education, cognitive ingenuity, innovative pedagogies, 3D printing, and CAD-CAM technologies.

How to cite this article: Kurtulmus-Yilmaz S, Önöral Ö. 2022. Effectiveness of screen-to-screen and face-to-face learning modalities in dental anatomy module during Covid-19 pandemic. Anat Sci Educ 15:63–66. https://doi.org/10.1002/ase.2150