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Quality, Effectiveness and Outcome of Blended Learning in Dental Education during the COVID Pandemic: Prospects of a Post-Pandemic Implementation

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Abstract: Abstract: BackgroundBlended learning is growing in popularity particularly following the emergence of COVID-19 pandemic. One of the fields that the pandemic has substantially affected is dental education. **Purpose**: The aim of this study was to evaluate the quality and effectiveness of the online dental education. Students' perceptions and experiences of blended learning were also investigated. **Methods**: A 28-question online survey was designed to gauge students' perceptions of the effect of blended learning on their academic performance. **Results**: 314 participants in preclinical and clinical years completed the questionnaire (223 females and 91 males). The majority of students (89%) believed that clinical and practical courses cannot be given by the internet. In terms of students' opinion in the assessment process, more females (65.8%) preferred traditional exams than males (50.5%) ($p < 0.05$). Most clinical students (83%) preferred a combination of online and traditional teaching compared to 72% of preclinical students ($p < 0.05$). Clinical year students were more willing to communicate electronically with their classmates and instructors. The majority of dental students (65%) reported that future dental courses should be blended. **Conclusions**: In the pandemic era, blended learning, should become the preferred method of education whereby theoretical knowledge is delivered through online tutorials and clinical training is resumed on-site, to ensure competency of dental graduates while maintaining safety of the dental team. Current facilities and course designs should be improved in order to improve students' experiences with blended learning.

Keywords: dental students; blended learning; effectiveness; perceptions

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1. Introduction

COVID-19 pandemic has brought ample changes in many areas of life, hindering the global health system, as well as society at large. Education is one of the aspects that has been markedly affected by the pandemic. In an effort to curb the spread of COVID-19 virus, several governments around the world temporarily closed educational institutions. Consequently, universities were required to promptly adopt several and diverse strategies for coping with this exceptional situation. Inevitably, both medical and dental schools had to take various measures to preserve the continuity of education while balancing the safety of students, professors, and patients and keeping pace of changing national legislation and guidelines.

Dental Schools were particularly affected by the COVID-19 pandemic due to the high risk of exposure of dental operators. Routine dental practice involves close face-to-face

communication with patients as well as generation of aerosols and droplets which are considered a major mode of transmission for COVID-19 virus [1]. Dental education, on both preclinical and clinical levels, has been profoundly influenced by this crisis.

Dental education is typically delivered in multiple settings including classroom, simulation laboratory and clinical environment. In most dental schools, students have a two-year preclinical and a two –to- three year clinical curriculum. Clinical dental interventions are considered a core component of dental education and require a safe work environment. Dental students undertake invasive procedures on patients which require an integration of interpersonal and technical skills.

Following the outbreak of COVID-19, dental schools had to undertake a range of measures to mitigate the spread of the pandemic. Most dental schools experienced difficulties in providing learning activities on campus and clinical training was suspended for varying periods of time. Remote learning using online platforms was used increasingly to provide some degree of continuity [2].

In Jordan, at the start of the pandemic in March 2020, the dental school at Jordan University of Science and Technology suspended all on-campus lectures and practical/clinical training, and e-learning activities were developed to maintain educational continuity. Three months later, as the epidemiological situation improved, limited clinical activities were allowed while non-clinical teaching continued to be delivered online.

Despite the gradual return to onsite education, a complete switch back to conventional face-to face education is not really expected due to the upredictability of the epidemiological situation. Given that the pandemic continues to impact on dental education, a flexible dental curriculum employing the online learning is becoming the forefront of educational modalities. The so-called Blended Learning (BL) approach has been growing in popularity particularly following the emergence of COVID-19 pandemic [3]. BL is one of the new major innovations in education that combines the benefits of traditional and online teaching methods [4]. Garrison and Kanula defined BL as the intentional combination of face-to-face and online learning activities in the classroom.

BL shifts the emphasis from teaching to learning, allowing students to become more involved and enthusiastic about the learning process, and increasing their perseverance and dedication [5]. Previous research by Edward et al. [6] and Ghazal et al. [7] showed that the BL technique improves students' learning engagement and experience by having a significant impact on students' awareness of the teaching style and learning background. It has been suggested that combining e-learning with a traditional lecture style complements traditional teaching techniques and may improve students' overall learning experiences by addressing differences in students' learning styles [8]. With the incorporation of asynchronous online education, students learn at their own pace and have more control over the learning process [9]. This self-regulated learning in online courses has been associated with higher academic achievement [10]. Qutieshat et al. [11] evaluated the effectiveness of blended learning in a clinical dental education setting based on students' performance and perceptions. Comparisons were made between integrated learning and traditional methods for all fourth-year dental students at a conservative dentistry course. The overall grades of the blended learning cohort were 7.25 points higher on average than those of the control cohort. Students who participated in the online forum also did better in the course.

It is worth mentioning that the implementation of digital technologies in dental education is not a novelty. In fact, it has started globally and reached varying levels of acceptence and penetration before the outbreak of COVID-19 pandemic [12]. However, following the pandemic, BL has become the dominant method for dental education nearly worldwide. BL has been used successfully and effectively in the various dental deciplines such as endodontics [13], orthodontics [14], periodontics [15] and application of local anesthesia [16]. However, variable students' perceptions and academic performance have been reported across studies [9,17–22]. This variation in student's responses could be attributed to the variable levels of school preparedness and degree of implementation of online learning technologies in dental education.

In Jordan, BL model was not really used in dental schools before the pandemic and the traditional face-to-face teaching was the main style for dental education.

To our knowledge, students' perceptions and attitudes of the BL model in Jordan during COVID 19 pandemic have not been investigated previously. Therefore, the aim of this study was to evaluate the quality and effectiveness of the blended dental education and its impact on assessments in Jordan. The study explored students' perceptions and experiences of about blended learning during the COVID-19 pandemic and sought to inform the future implementation of blended learning in dental curricula.

2. Materials and Methods

2.1. Study Design

This was a cross-sectional exploratory study based on an online survey (Appendix A). The survey instrument was designed to gauge students' perceptions of the effect of online applications and animations on their academic performance.

The questionnaire was comprised of 28 questions which included Likert scale questions and yes/no (Appendix A). Responses to Likert scale questions were based on scores from 1 to 5, with 1 representing a positive response, up to 5 representing a negative response. For the analysis of data, "strongly agree" and "agree" responses were given code 1, neutral response code 2, and "disagree" and "strongly disagree" responses were given code 3.

The questions were adopted form the study by Turkyilmaz et al. [23] and sought to address all important aspects in relation to BL impact on students and learning process. The questionnaire was divided into 7 main categories. These categories were; the perceived importance of dental e-learning, students' opinion in the distant online dental assessments process, communication with staff and classmates during the e-learning process, educational modalities and access to educational material, effectiveness of the online learning experience, students' assessment of their blended learning experience and students views of the future dental education.

2.2. Participants

Purposive sampling technique was used to target pre-clinical (second- and third-year), and clinical years (fourth and fifth -year) dental students at Jordan University of Science and Technology. First-year dental students were excluded due to their insufficient exposure to didactic, practical and clinical dental courses.

2.3. Data Collection

The survey was administered online, and data collection was anonymised. All participants completed it anonymously on their chosen device and browser, at a time and place convenient for their schedules. There was no collection of Internet Protocol (IP) addresses for computers. The poll's secrecy meant that investigators had no method of identifying the students who participated.

A participant information sheet accompanied the invites and the participants were required to sign an online consent prior to providing their responses. Data collection was completed over three-month period form May to August 2021.

2.4. Data Analysis

Data derived from the online questionnaire was downloaded directly onto an Excel spreadsheet. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) software version 22.0 (IBM Co., Armonk, NY, USA) to derive frequency tables and descriptive statistics. Chi-square test was used to detect any difference between groups. Significance level was set at $p < 0.05$.

3. Results

The estimated total number of dental students targeted for this study was 1300. Of these, 314 participants completed the questionnaire giving a response rate of 25%. The sample comprised of 223 (71%) females and 91 (29%) males. The study involved 83 (26.4%) preclinical-years' and 231 (73.6%) clinical years' dental students.

3.1. Students' Perceived Importance of Dental E-Learning

Students were asked about the role of online teaching in lectures and clinical/practical classes. The number (percentage) of students who agreed that e-learning replaces the traditional education in lectures was 114 (36.3%) while 139 (44.3%) disagreed with this statement. There were no statistically significant differences between males and females, and between preclinical and clinical students (Table 1).

Table 1. Students' opinion regarding the applicability of online dental education.

Questions/Response	Gender		Type of Students		Total
	Female	Male	Clinical	Pre-Clinical	
E-Learning Complements Traditional Education in Lectures and Practical/Clinical Sessions					
Agree	88 (40%)	42 (47%)	107 (46.3%)	23 (29.5%)	130 (42.1%)
Neutral	76 (35%)	35 (39%)	81 (35.1%)	30 (38.5%)	111 (35.9%)
Disagree	55 (25%)	13 (14%)	43 (18.6%)	25 (32.1%)	68 (22%)
Pearson Chi-Square (p value)	4.25 (0.120 NS)		8.90 (0.012 *)		
E-Learning Replaces Traditional Education in Lectures					
Agree	75 (34%)	39 (43%)	79 (34.2%)	35 (42.2%)	114 (36.3%)
Neutral	46 (21%)	15 (16.5%)	49 (21.2%)	12 (14.5%)	61 (19.4%)
Disagree	102 (46%)	37 (41%)	103 (44.6%)	36 (43.4%)	139 (44.3%)
Pearson Chi-Square (p value)	2.46 (0.292 NS)		2.52 (0.283 NS)		
E-Learning Replaces Traditional Education in Some Practical/Clinical Classes (Demo)					
Agree	35 (16%)	21 (23%)	46 (19.9%)	10 (12%)	56 (17.8%)
Neutral	46 (21%)	22 (24%)	52 (22.5%)	16 (19.3%)	68 (21.7%)
Disagree	142 (64%)	48 (53%)	133 (57.6%)	57 (68.7%)	190 (60.5%)
Pearson Chi-Square (p value)	3.63 (0.163 NS)		3.656 (0.161 NS)		
E-Learning Is of No Use					
Agree	28 (13%)	9 (10%)	27 (11.7%)	10 (12%)	37 (11.8%)
Neutral	65 (29%)	25 (27.5%)	68 (29.4%)	22 (26.5%)	90 (28.7%)
Disagree	130 (58%)	57 (62.5%)	136 (58.9%)	51 (61.4%)	187 (59.6%)
Pearson Chi-Square (p value)	0.66 (0.720 NS)		0.26 (0.879 NS)		

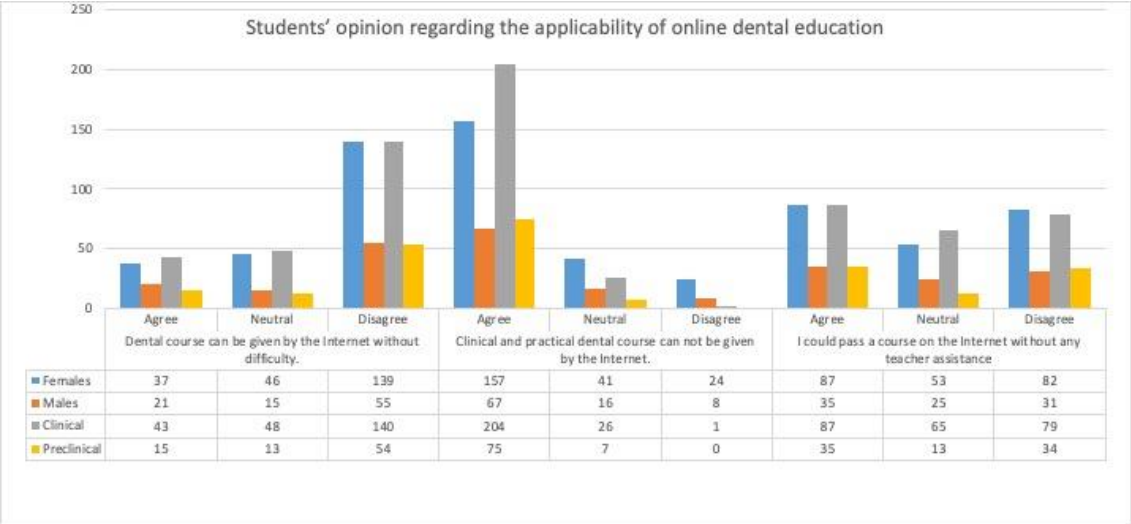
Note: NS non-significant; * $p < 0.05$.

With regard to the use of online teaching for practical/clinical classes, the majority of students (89%) believed that clinical and practical courses cannot be given by the internet.

A statistically significant difference was detected among clinical and preclinical students ($p < 0.05$). when they were asked if e-learning complements traditional education in lectures and practical/clinical sessions. A hundred and seven (46.3%) of clinical years students agreed and 43 (18.6%) disagreed compared to 23 (29.5%) and 25 (32.1%) students in preclinical years who agreed and disagreed, respectively.

More than half of the students disagreed that e-learning was not useful. No statistically significant differences were detected in respect to gender and the type of studied courses

($p > 0.05$). Almost 40% of students reported that they find it easy to self-study and they could pass an online course without any teacher assistance (Figure 1).

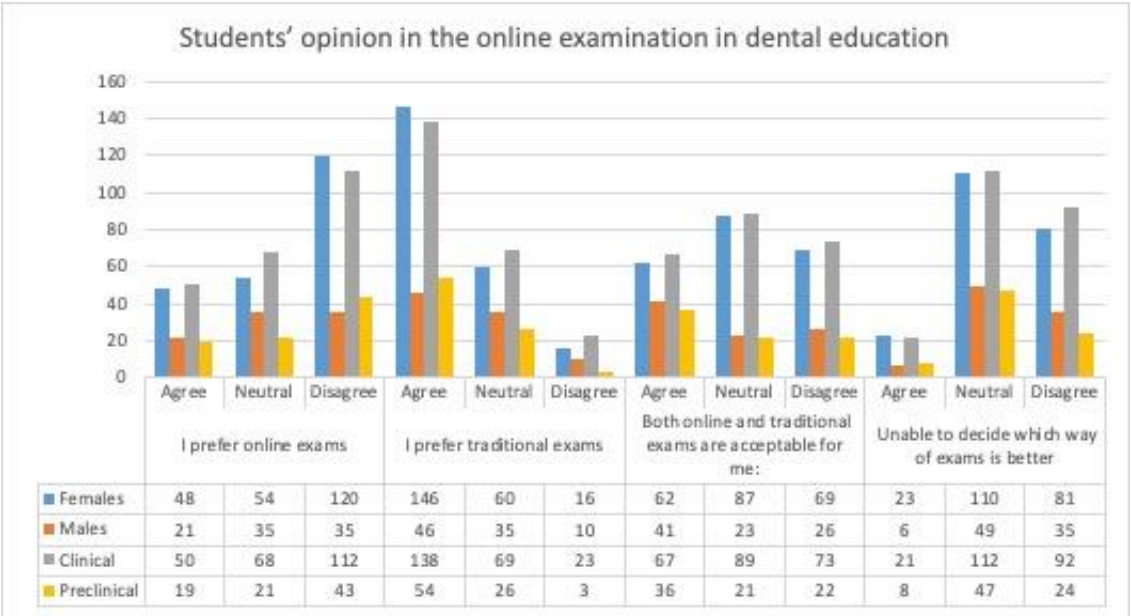


	Agree	Neutral	Disagree	Agree	Neutral	Disagree	Agree	Neutral	Disagree
	Dental course can be given by the Internet without difficulty.			Clinical and practical dental course can not be given by the Internet.			I could pass a course on the Internet without any teacher assistance		
Females	37	46	139	157	41	24	87	53	82
Males	21	15	55	67	16	8	35	25	31
Clinical	43	48	140	204	26	1	87	65	79
Preclinical	15	13	54	75	7	0	35	13	34

Figure 1. Students' opinion regarding the applicability of online dental education.

3.2. Students' Opinion in the Distant Online Dental Assessments

In terms of students' opinion in the assessment process, more females (65.8%) preferred traditional exams than males (50.5%) ($p < 0.05$). Traditional onsite online exams were the preferred assessment process by the majority of dental students (61%) as shown in Figure 2.



	Agree	Neutral	Disagree	Agree	Neutral	Disagree	Agree	Neutral	Disagree	Agree	Neutral	Disagree
	I prefer online exams			I prefer traditional exams			Both online and traditional exams are acceptable for me:			Unable to decide which way of exams is better		
Females	48	54	120	146	60	16	62	87	69	23	110	81
Males	21	35	35	46	35	10	41	23	26	6	49	35
Clinical	50	68	112	138	69	23	67	89	73	21	112	92
Preclinical	19	21	43	54	26	3	36	21	22	8	47	24

Figure 2. Students' opinion in the online examination in dental education.

3.3. Students' Communication with Staff and Classmates during the E-Learning

More than one half of dental students 158 (50.5%) reported that they received a quick response to their questions during internet activities outside of class.

The majority of dental students 224 (72%) in the various levels of dental study felt that face-to-face contact with their instructor was necessary for better learning. Gender, and type of the studied courses did not affect students' response ($p > 0.05$).

Although pre-clinical students (42%) reported they feel comfortable to communicate online, clinical year students were more willing (77%)to communicate electronically with their classmates and instructors compared to preclinical students (34%) ($p < 0.05$).

3.4. Educational Modalities and Access to Educational Material

During the pandemic, the following educational material were available; lecture presentations and handouts by their instructors and educational resources in the form of videos and pictures as reported by the participants (92.7%). Two hundred and twenty-four (72%) students reported that educational material was available all the time (Table 2). Students' dental learning involved different educational modalities such as face-to-face teaching, online assignments, seminars and group discussions, procedural video illustrations, individual learning and quizzes. Students' responses to their access to educational resources are illustrated in Figure 3.

Table 2. Access to educational material during the pandemic.

Questions/Response	Gender		Type of Students		Total
	Female	Male	Clinical	Pre-Clinical	
Presentations and Lecture Handouts Were Given by Instructors					
Yes	205 (92%)	85 (94%)	214 (93%)	76 (91.6%)	290 (92.7%)
No	18 (8%)	5 (6%)	16 (7%)	7 (8.4%)	23 (7.3%)
Pearson Chi-Square (p value)	0.60 (0.440 NS)		0.19 (0.658 NS)		
You had access to staff lectures all the time					
Yes	161 (72.5%)	63 (71%)	171 (755)	53 (63.9%)	224 (72%)
No	61 (27.5%)	26 (29%)	57 (25%)	30 (36.1%)	87 (28%)
Pearson Chi-Square (p value)	0.10 (0.758 NS)		3.75 (0.053)		
You had access to educational resources as videos (YouTube) and pictures					
Yes	207 (93%)	85 (93%)	214 (92.6%)	78 (94%)	292 (93%)
No	16 (7%)	6 (7%)	17 (7.4%)	5 (65)	22 (7%)
Pearson Chi-Square (p value)	0.034 (0.855 NS)		0.17 (0.683 NS)		

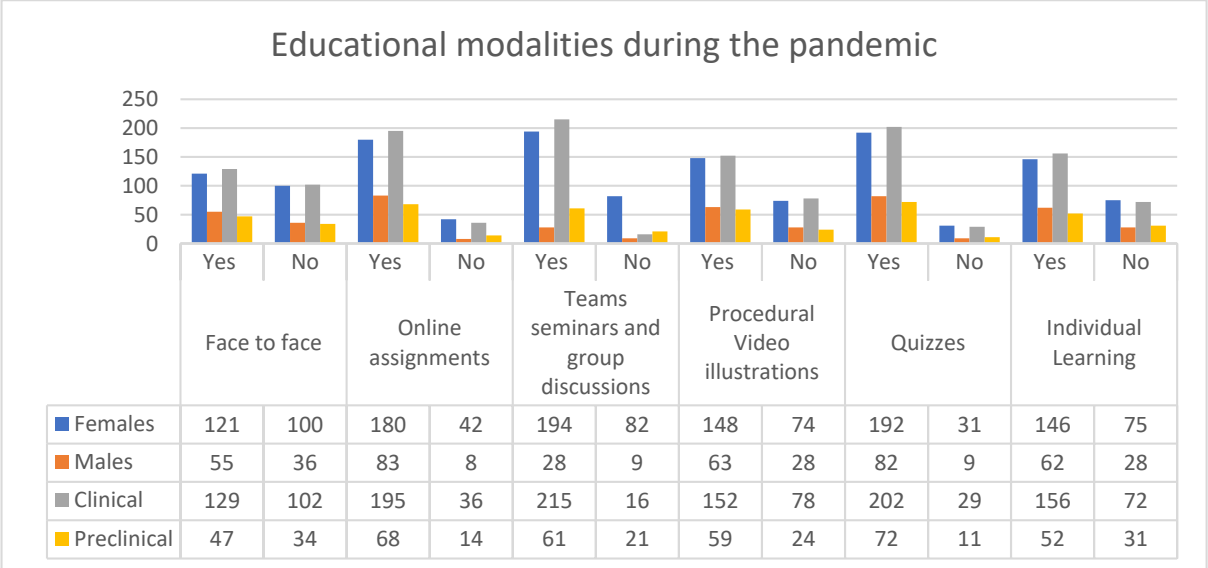


Figure 3. Educational modalities during the pandemic.

3.5. Effectiveness of the Online Learning Experience

Dental students were also asked to indicate their perceived effectiveness of online learning. The majority, 283 (90.1%) dental students indicated that further improvement to online tutorials was needed to support the online learning process. Only 88 (28.1%) students reported that online courses achieved their learning outcome. Gender difference was detected where more males (44%) disagreed that the online courses achieved their designated learning outcome ($p < 0.05$) (Figure 4).

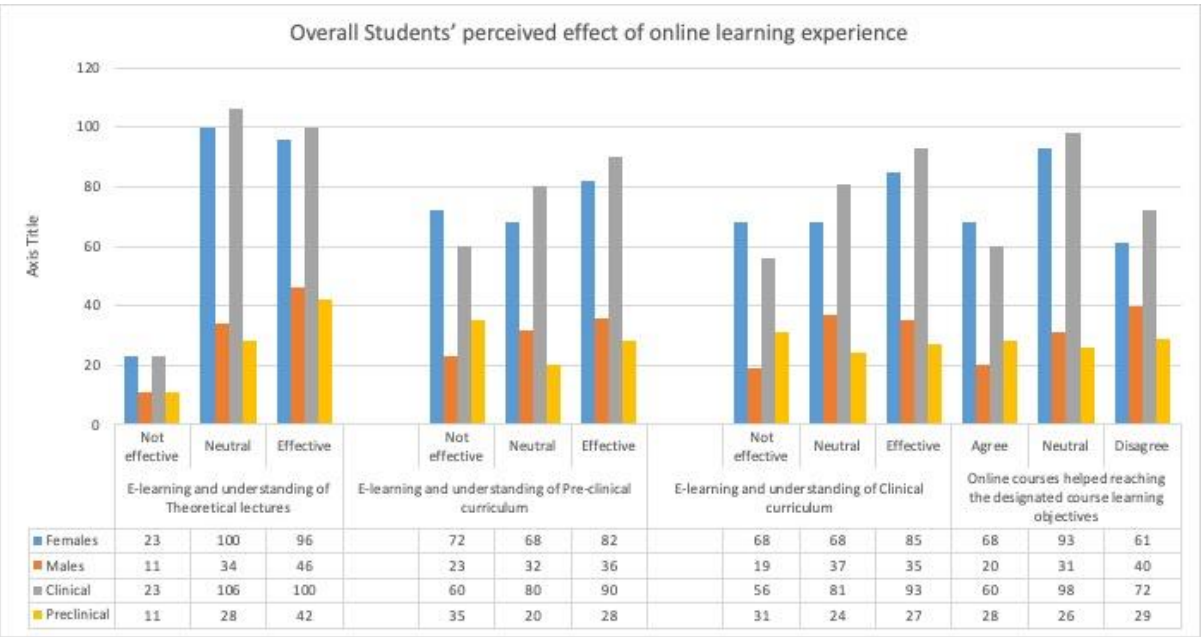


Figure 4. Overall Students' perceived effect of online learning experience.

More than half of students (52.9%) disagreed that online lectures were more useful than traditional ones. Most students preferred live demonstrations over procedural videos and online tutorials for lab sessions and preclinical courses (Table 3).

For clinical courses, a large proportion of students, 246 (78.6%) disagreed that online tutorials should replace traditional lectures and live demonstrations.

However, most clinical students (82.6%) preferred a combination of online and traditional teaching compared to 72.3% of preclinical students ($p < 0.05$). No significant differences in respect to gender were detected ($p > 0.05$).

Table 3. Students' perceived effect of online learning experience.

Questions/Response	Gender		Type of Students		Total
	Female	Male	Clinical	Pre-Clinical	
Online Courses Helped Reaching the Designated Course Learning Objectives					
Agree	68 (30.6%)	20 (22%)	60 (26.1%)	28 (33.7%)	88 (28.15)
Neutral	93 (41.9%)	31 (34.1%)	98 (42.6%)	26 (31.3%)	124 (39.6%)
Disagree	61 (27.5%)	40 (44%)	72 (31.3%)	29 (34.9%)	101 (32.3%)
Pearson Chi-Square (*p* value)	8.15 (0.017 *)		3.48 (0.176 NS)		
Online Tutorials Need Further Improvement to Support My Learning					
Yes	204 (91.5%)	79 (86.8%)	209 (90.5%)	74 (89.2%)	283 (90.1%)
No	19 (8.5%)	12 (13.2%)	22 (9.5%)	9 (10.8%)	31 (9.9%)

Table 3. *Cont.*

Questions/Response	Gender		Type of Students		Total
	Female	Male	Clinical	Pre-Clinical	
Pearson Chi-Square (*p* value)	1.58 (0.209 NS)		0.12 (0.730 NS)		
Online Flash Lectures Were More Useful than Traditional Lectures					
Yes	102 (45.9%)	45 (50%)	107 (46.5%)	40 (48.8%)	147 (47.1%)
No	120 (54.1%)	45 (50%)	123 (53.5%)	42 (51.2%)	165 (52.9%)
Pearson Chi-Square (*p* value)	0.422 (0.515 NS)		0.12 (0.725 NS)		
Procedural Videos Were More Useful than Live Demonstrations during Lab Sessions					
Yes	68 (30.5%)	35 (38.5%)	81 (35.1%)	22 (26.5%)	103 (32.8%)
No	155 (69.5%)	56 (61.5%)	150 (64.9%)	61 (73.5%)	211 (67.2%)
Pearson Chi-Square (*p* value)	1.86 (0.172 NS)		2.03 (0.154 NS)		
Online Tutorials Should Replace Traditional Lectures and Live Demonstrations for Preclinical Courses					
Yes	63 (28.4%)	31 (35.2%)	72 (31.6%)	22 (26.8%)	94 (30.3%)
No	159 (71.6%)	57 (64.8%)	156 (68.4%)	60 (72.3%)	216 (69.7%)
Pearson Chi-Square (*p* value)	1.40 (0.237 NS)		0.64 (0.422 NS)		
Online Tutorials Should Replace Traditional Lectures and Live Demonstrations for Clinical Courses					
Yes	45 (2.2%)	22 (24.4%)	52 (22.6%)	15 (18.1%)	67 (21.4%)
No	178 (79.8%)	68 (75.6%)	178 (77.4%)	68 (81.9%)	246 (78.6%)
Pearson Chi-Square (*p* value)	0.69 (0.405 NS)		0.75 (0.388 NS)		
I Prefer a Combination of Traditional Teaching and Online Tutorials					
Yes	180 (80.7%)	70 (57.5%)	190 (82.6%)	60 (72.3%)	250 (79.9%)
No	43 (19.3%)	20 (22.2%)	40 (17.4%)	23 (27.7%)	63 (20.1%)
Pearson Chi-Square (*p* value)	0.35 (0.557 NS)		4.04 (0.044 *)		

Note: NS non-significant; * $p < 0.05$.

3.6. Students' Assessment of Their Blended Learning Experience

More than one half 167 (54%) of dental students reported that they feel more confident with blended learning. A hundred and sixty-three (52%) students believed blended learning helped them remember better what they have learned and almost 60% of dental students disagreed or were not able to decide whether blended dental education improved their dental knowledge and dental skills. Almost one half of the females dental students reported that blended learning did not prepare them well to embark on treating patient ($p < 0.01$). Nighty four of females, (42%) reported that blended learning resulted in a drop of their assessment scores while 32% of males reported a better assessment score ($p < 0.05$) (Figure 5).

3.7. Students Views of the Future Dental Education

Interestingly, 60.8% of dental students indicated that future dental education should not be entirely face to face. Gender and type of students' differences were detected ($p < 0.05$).

Majority of dental students, 145 (65%) reported that future dental courses should be blended and e-learning should be at least 50% of the didactic courses, while 75% of the students reported that e-learning should be less than 25% of the combined didactic and practical/clinical courses (Table 4).

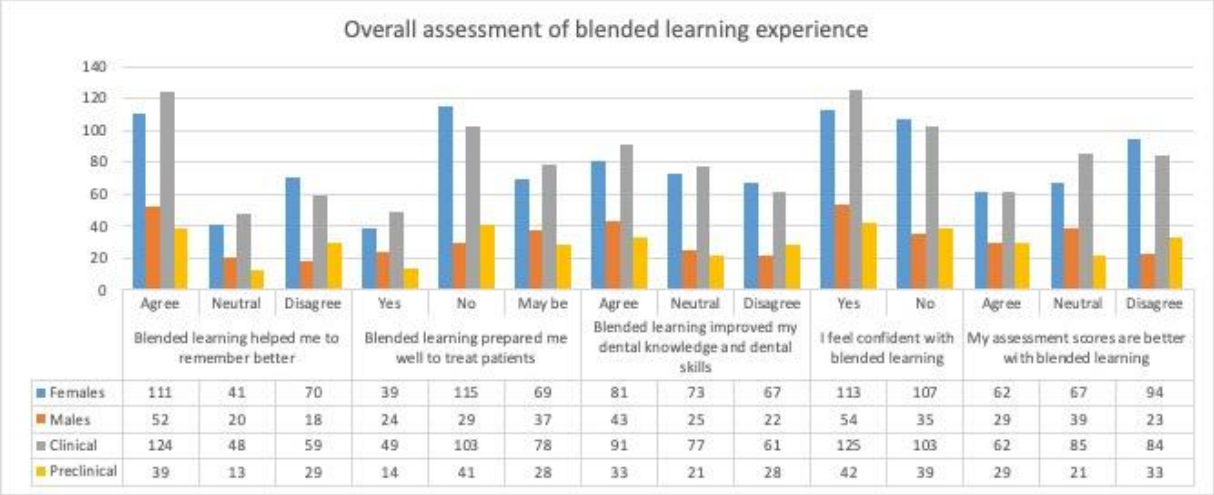


Figure 5. Overall assessment of blended learning experience.

Table 4. Students' opinions regarding future dental Education.

Questions/Response	Gender		Type of Students		Total
	Female	Male	Clinical	Pre-Clinical	
Future Dental Education Should Be Face to Face					
Yes	94 (42.7%)	27 (30.3%)	80 (35.1%)	41 (50.6%)	121 (39.2%)
No	126 (57.3%)	62 (69.7%)	148 (64.9%)	40 (49.4%)	188 (60.8%)
Pearson Chi-Square (*p* value)	4.08 (0.043 *)		6.05 (0.014 *)		
Future Didactic Dental Courses Should Be Blended and E-Learning Should Be					
Less than 25%	77 (34.7%)	29 (32.2%)	74 (32.2%)	32 (39%)	77 (34.7%)
25–50%	68 (30.6%)	26 (28.9%)	75 (32.6%)	19 (23.2%)	68 (30.6%)
More than 50%	77 (34.7%)	35 (38.9%)	81 (35.2%)	31 (37.8%)	77 (34.7%)
Pearson Chi-Square (*p* value)	0.49 (0.781 NS)		2.74 (0.255 NS)		
Future Clinical and Practical Dental Courses Should Be Blended and E-Learning Should Be					
Less than 25%	132 (60%)	45 (49.5%)	123 (53.2%)	54 (67.5%)	177 (56.9%)
25–50%	44 (20%)	26 (28.6%)	54 (23.4%)	16 (20%)	70 (22.5%)
More than 50%	44 (20%)	20 (22%)	54 (23.4%)	10 (12.5%)	64 (20.6%)
Pearson Chi-Square (*p* value)	3.80 (0.284 NS)		6.33 (0.097 NS)		
Future Dental Education in Combined Didactic and Clinical/Practical Courses Should Be Blended and E-Learning Should Be					
Less than 25%	164 (4.5%)	67 (74.4%)	173 (75.2%)	58 (72.5%)	231 (74.5%)
25–50%	46 (20.9%)	17 (18.9%)	46 (20%)	17 (21.3%)	63 (20.3%)
More than 50%	10 (4.5%)	6 (6.7%)	11 (4.8%)	5 (6.3%)	16 (5.2%)
Pearson Chi-Square (*p* value)	0.69 (0.710 NS)		0.35 (0.839 NS)		

Note: NS non-significant; * $p < 0.05$.

4. Discussion

This study sought to assess effectiveness and outcome of BL in dental education during COVID-19 pandemic. To our knowledge, this is the first study exploring perceptions and experience of dental students with blended learning in Jordan.

BL is defined as a hybrid of online and traditional face-to face education that seeks to involve students more actively in the learning process [24]. BL has been shown to be successful and effective in improving students' performance and learning experience [8,10].

However, this blended teaching method was not really used in dental schools in Jordan before the pandemic and the traditional face-to-face teaching was the main style for dental education.

The COVID-19 pandemic has imposed dramatic changes and great challenges to dental education worldwide. In Jordan, on the 15th of March 2020, all dental schools were closed down and traditional face-to-face education was suspended in response to governmental legislations to handle the pandemic. Consequently, distance learning has emerged and was adopted as a new method of teaching to maintain the learning process while ensuring safety of students, staff and patients.

The study evaluated the impact of BL on both preclinical (second-and third-year) and clinical (fourth-and fifth-year) dental students. First-year students were not included in this study as they do not have dental courses in their curriculum.

When students were asked about their perceived importance and effectiveness of e-learning in replacing traditional education in lectures, more than third of the sample agreed with this statement. This could be attributed to the fact that lectures often focus on delivering theoretical knowledge in dental science and this could be readily and successfully delivered through online or remote learning. Nonetheless, a substantial proportion of students (>40%) in both preclinical and clinical students disagreed that e-learning is a sufficient substitute to traditional learning in lectures, likely due to the fact that the online teaching is still somewhat new to dental students in Jordan and they are still not so used to it. Despite this disagreement, more than one half of the students agreed that e-learning was useful. This conforms with results by Amir et al. [25] who found that although most students agreed that online learning was a more efficient learning style, only 44% of students preferred distance learning over classroom learning methods. This was mainly attributed to technical problems and lack of stable internet connection among surveyd students.

For practical classes, the students' response was different; more than half of the students disagreed that e-learning was a good replacement of traditional teaching. Practical classes involved lab sessions for preclinical students and the clinical training for 4th and 5th-year students.

Lab sessions are often interactive and involve illustration or demonstration of a specific procedure along with hands-on skill acquisition. In the present survey, most students preferred live demonstrations over recorded videos and online tutorials for lab sessions.

The clinical training does not only involve teaching and practicing clinical skills but also aims at improving students' critical thinking and clinical reasoning for the various 'real scenario' situations. This in-person experience and direct patients care in clinical classes cannot be easily substituted by electronic teaching regardless of the technology used. Hence, it is understandable why most students in clinical years disagreed that distance learning could replace the traditional teaching. Sharka et al. [26] indicated that relying solely on online education can be justified and rational for providing theoretical information and non-clinical teaching for the first three years of dentistry programs. However, this does not apply on clinical training which cannot be simply substituted even by the most advanced online technology [26]. In the current sample, the majority of students (89%) believed that clinical and practical courses cannot be given by the internet. This conforms with findings by Cheng et al. who reported that changing to online teaching was feasible but not for dental professional courses with laboratory formats [22]. Similarily, in a study by Van Doren et al. [27] students appreciated the online teaching but believed that it could not replace the direct patient care. Medical students also disagreed that e-learning can be used to teach clinical aspects [28]. However, it noteworthy to mention that dental education differs significantly from medical education in that there is a great emphasis on acquisition of manual skills to ensure competency of dental graduates. Therefore, a stronger impact on dental education was imposed by the pandemic. This issue has been described as one of the major challenges for dental education during COVID-19 pandemic [29–31].

Interestingly, more clinical students (46.3%) agreed that e-learning complements traditional teaching compared to preclinical students (29.5%). The difference was statistically

significant (p-value < 0.05). Comparatively, Gungor et al. found that online learning was more preferred by the senior students and attributed that to the fact that younger students may have difficulty understanding and following online lessons as they have not acquired enough background in the field [9].

In terms of exam, most students preferred traditional exams over online ones. This could be attributed to technical issues such as internet limitations and lacking suitable devices. A recent cross-sectional survey of students at faculties of Medical Sciences at the Jordan University of Science and Technology also found that in-campus exams were preferred by the majority of the students compared to remote E-exams [32]. In the latter study, the majority of students reported that more efforts/time were needed to prepare for remote electronic exams compared with in-campus. Furthermore, questions inappropriateness with study material, unsatisfactory academic achievement as well as exam dishonesty and misconduct were among the major issues reported with electronic exams [32]. Interestingly, the preference of traditional exams was particularly evident among females in the current sample. In view of the aforementioned issues associated with online or remote exams as well as the increased anxiety scores reported among females during the pandemic [33,34], it is comprehendible why most females in the current study prefererd traditional exams over distant ones.

With regard to communication during the e-learning process, more than half of students in the current work indicated they received a quick response to their questions during internet activities outside class. Al-Balas et al. also reported that communication with colleagues and instructors was not hampered by being off-campus and interacting online [35]. Furthermore, the present study reported that students in their final years were more willing to communicate electronically with their instructors and classmates. This concurs with findings by Hattar et al. who reported higher social interaction among students in their final years and attributed that to likely spending more time of working and interacting together [20].

Although a significant proportion of students (79%) in clinical years reported that online tutorials alone were not sufficient replacement to traditional teaching, the majority favoured a combination of online and traditional education. In the current study, student's views about the BL were generally positive. This concurs with the results by Varthis & Anderson among dental students where positive perceptions of BL were reported [36]. In fact, numerous studies in the literature reported genrally positive attitudes of online tutorials among dental students [9,20–22]. This indicates that BL has a strong potential to be the accepted method of education among dental students in the future. A study of dental education in the COVID-19 era, suggested that the current pandemic is an excellent opportunity to adjust and optimize the current teaching methods; while the traditional on-site teaching for undergraduate students remains a core element, online tutorials and the new electronic strategies should be incorporated in the process [26]. Likewise, Hung et al. [37] suggested that, in the era of COVID-19, dental education may be adjusted and enriched by incorporation of new elearning methods as students appeared comfortable with adaptaion to modern technologies.

In the current survey, th majority of dental students, 145 (65%) reported that future dental courses should be blended and e-learning should be at least 50% of the didactic courses. This concurs with findings by Schlenz et al. [17] who reported that students were generally positive about implementation of online courses in future curriculum and suggested to keep it up in more than 50% of the courses.

Online learning could bring numerous advantages to learners such as increasing students participation and fostering their interactions [38,39]. Distance learning could be a more flexible way of teaching giving students a more convenient access to teaching material. Other reported benefits of online learning include being time saving, with no time or space restraints, flexibility of class time, better instruction, better interaction with instructor and classmates [35]. A survey of polish medical students reported more advantages for online learning; these included ability to stay at home, continuous access to online materials,

learning at your own pace and comfortable surroundings [40]. In the present study, most students indicated that they had access to educational material in various modalities all the time; this is considered another advantage of online teaching whereby students have more control over their learning time and sequence. Nijakowski et al. [13] investigated the effectiveness of BL in conservative dentistry among 4th-year dental students and reported that most respondents preferred remote learning in an asynchronous form compared to synchronous one and attributed that particularly to the indivisualised pace of learning. In the latter study, the majority of students highly rated BL and indicated that the proposed BL model increased their learning efficiency and quality of teaching in comparison to pre-COVID period. Moreover, Turkyilmaz et al. [23] reported that e-learning had a significant positive impact on students's understanding of didactic and clinical composnents.

On the other hand, almost half of students indicated that blended learning did not prepare them well to start their professional career. The clinical exposure has been reported as the most important factor affecting preparedness of final year dental students [41]. In view of the limited clinical training allowed following the pandemic, it can be explained why students in the current survey felt that their level of preparedness was not satisfactory. Furthermore, more males in the present investigation disagreed that the online courses achieved their designated learning outcome. The effect of gender on online learning outcome is reported with controversy in the literature [39]. It is thought that females could achieve higher learning outcomes because they are genrally more persistent and commited than males [42]. Alghamdi et al. reported that females had stronger self-regulation than males which led to higher online learning outcomes [43].

In the current study, the majority of students (90%) reported that further improvement to online tutorials was needed. A similar study among medical students in Jordan reported that only about one fourth of students were satisfied with their experience in distance learning [35]. In order to improve students' experience with BL, the authors believe that current facilities and course designs should be improved. Institutional support and adequate time from instructors are required in order to implement a successful BL experience among students [11].

Overall, dental students appreciate the virtual classes and welcome the blended learning model with the introduction of modern e-technologies into the teaching process, however, students invariably across studies believe that clinical aspects and manual skills can not be taught virtually and that in-person experience with patients is a cornerstone in dental education and must continue to ensure competency of future dentists while balancing safety of the dental team.

It is noteworthy to mention that the results of the current survey are not readily generalizable as it involved one dental school only with a relatively small smaple; a nationwide investigation or even a global perspective would give a more valuable insight into students' attitudes and perceptions and a more meaningful results to inform educators and policy-makers on the future education.

5. Conclusions

The COVID-19 pandemic is likely to change the approach to dental education worldwide. BL offers several advantages over the traditional face-to-face teaching, most importantly being more flexible and more engaging to students in the learning process. The clinical exposure is still intergral in the dental curriculum and can not be replaced by remote teaching regardless of the e-technology used in order to ensure competrency of dental graduates. In the pandemic era, BL should become the method-of-choice for undergraduate education, whereby lectures and theoretical foundation is delivered through online tutorials, and clinical training is resumed on-site through a very well-structured program where rotation system is followed to avoid overcrowding, social distancing is kept, and infection control measures are strictly adhered to.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Blended Learning Questionnaire

Level of Study	**Second Year**	**Third Year**	**Fourth Year**	**Fifth Year**	
Gender	Male	Female			
Date of Birth					
Course name and code					
Type of course	Theory				
	Practical				
	Clinical				
	Practical and theory				
	Clinical and theory				
Nationality	Jordanian	Non-Jordanian			
Accumulative Average	Excellent	V. Good	Good	Fair	Pass
Average before the pandemic					
Average after the pandemic					
Available online education tools	PC	Ipad/Tablet	Mobile	Labtop	
I am able to easily access the Internet as needed for my studies.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Based on your experience in all dental courses, please comment on the impact of online learning on your academic performance					
E-learning compliments traditional education in lectures and practical sessions	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
E-learning replaces traditional education in lectures	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
E-learning replaces traditional education in some practical classes (demo)	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
E-learning is of no use	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Level of Study	Second Year	Third Year	Fourth Year	Fifth Year	
Regarding online assessment process					
I prefer online exams	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I prefer traditional exams	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Both are acceptable for me	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Unable to decide	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
My assessment scores better with blended learning	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Communication with teaching staff and classmates					
I can ask my teacher questions and receive a quick response during Internet activities outside of class.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I feel that face-to-face contact with my instructor is necessary to learn.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I am comfortable communicating electronically.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I am willing to actively communicate with my classmates and instructors electronically.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I feel comfortable communicating online in English.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can practice English grammar during Internet	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can discuss with other students during Internet activities outside of class.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can collaborate with other students during Internet activities outside of class.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can work in a group during Internet activities outside of class.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I prefer Interactive learning (real time interaction)	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I prefer Asynchronous Learning (content is available online for students to access when it best suits your schedules)	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Do you think blended learning prepared you well to embark on treating patients	Yes	No			
Do you get presentations and lecture handouts from your instructor	Yes	No			

Level of Study	Second Year	Third Year	Fourth Year	Fifth Year		
Do you have access to lectures all the time						
Do you have access to educational resources as videos (Youtube) and pictures	Yes	No				
Do ypu have access links to external resources in different courses	Yes	No				
Learning modalities that you were exposed to						
Face to face instructions	Yes	No	<25%	<50%	=50%	>50%
Online assignments	Yes	No				
Teams seminars and group discussions	Yes	No				
Individual learning	Yes	No				
Procedural Video illustrations	Yes	No				
Quizzes	Yes	No				
Regarding online applications/animations, please rate the following factors as to their influence on your academic performance						
Online presentation 30 min/Topic	(1 = least influence and 5 = most influence)					
Demonstration of any dental procedure	(1 = least influence and 5 = most influence)					
Online presentation 45 min./Topic	(1 = least influence and 5 = most influence)					
Organization/logic of the online tutorials content	(1 = least influence and 5 = most influence)					
What perceived effect would e-learning have on your understanding of a topic?						
E-learning within DIDACTIC lectures	(1 = least influence and 5 = most influence)					
E-learning within CLINICAL curriculum	(1 = least influence and 5 = most influence)					
E-learning within practical curriculum	(1 = least influence and 5 = most influence)					
How effective was the the online course at helping you reach designated learning objectives?	(1 = least influence and 5 = most influence)					
Online tutorials need further improvement to support my learning	Yes	No				
Online flash lectures were more useful than traditional lectures	Yes	No				
Procedural videos were more useful than live demonstrations during lab sessions	Yes	No				
Online tutorials need further improvement to support my learning	Yes	No				

Level of Study	**Second Year**	**Third Year**	**Fourth Year**	**Fifth Year**	
Online tutorials should replace traditional lectures and live demonstrations for preclinical courses	Yes	No			
Online tutorials should replace traditional lectures and live demonstrations for clinical courses	Yes	No			
I prefer a combination of traditional teaching and online tutorials	Yes	No			
Online lectures were helpful to my learning	Yes	No			
Procedural videos were helpful to my learning	Yes	No			
Online lectures were helpful to my learning	Yes	No			
Do you attend online tutorials daily	Yes	No			
Describe your attendance					
	I prefer online classes only	I prefer traditional lecture mixed with online learning	I prefer tradition lecture style only	My attendance is not related to the lecture format (classroom or online)	
Do you attend online tutorials daily	Yes	No			
As a dental student, at what year do you think that online tutorial will help the students more					
Second year	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Third year	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Fourth year	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Fifth year	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I believe looking back on what I have learned through blended learning will help me to remember it better.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I believe all dental course can be given by the Internet without difficulty.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I believe clinical and practical dental course can not be given by the Internet.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
In my studies, I am self-disciplined and find it easy to set aside reading and homework time.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I could pass a course on the Internet without any teacher assistance	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Level of Study	Second Year	Third Year	Fourth Year	Fifth Year	
I believe blended dental education will improve my dental knowledge and dental skills.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Future dental education should be blended and at least——e-learning	<25%	<50%	=50%	>50%	
Future dental education should be face to face only	yes	no			
Future dental education in clinical and practical courses should be blended and at least——e-learning	<25%	<50%	=50%	>50%	
Future dental education in combined courses (theory and clinical/practical) may be blended with at least——e-learning	<25%	<50%	=50%	>50%	
I feel more confident with blended learning	yes	No			

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