

Online vs. traditional learning: A comparative analysis of student's responses during COVID-19

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Abstract.

BACKGROUND: The coronavirus 2019 (COVID-19) pandemic had a major impact on the educational institutes globally and resulted in the transition from traditional educational systems to online electronic learning methods.

OBJECTIVE: This study endeavored to address and compare the dental student's understanding regarding the Oral Biology course by assessing their knowledge and skills between the students enrolled during 2020 (online teaching) and 2021 (face-to-face teaching). This study also aimed to assess the perception of dental students regarding the virtual mode of teaching.

METHODS: This quasi-experimental study evaluated students from two years, in which a retrospective group of dental students enrolled during the academic year 2020 were compared with a prospective experimental group enrolled during the academic year 2021. Knowledge and skills for both years were compared. This comprised of theoretical and practical component. Students also completed a questionnaire that assessed student's perception regarding online teaching.

RESULTS: A total of 98 students of Bahria University Dental College participated. A comparison between grade scores of online and traditional learning groups reported statistically significant differences ($p=0.05^*$) with regards to short answer question types, viva or verbal questions ($p=0.016^*$). Strong correlations were observed via the multivariable analysis. All correlations were statistically significant at $p<0.01$ level. Learning satisfaction was not satisfactorily observed by the online learning group.

CONCLUSION: It can be concluded that despite the disruption that the educational sector had to face due to the COVID-19 pandemic, based on the differences in the subjective domain scores, students appeared to like on-campus teaching more than the online teaching, as most students found online learning to be stressful and were quite unsatisfied. However, the difference in mode of teaching did not affect the knowledge and skills of the dental students.

Keywords: Online learning, COVID-19, traditional learning, dental students

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1. Introduction

The coronavirus 2019 (COVID-19) pandemic, which emerged from China and readily propagated to every continent, severely disturbed and affected the health, economy, psychology as well as education due to the strict lockdown measures, imposed to curb the graveness of the deadly virus [1]. The pandemic disturbed around 1.6 billion learners across 200 different countries, causing the highest disruption in education systems known to mankind [2]. Supportive measures such as working from home and monthly financial scholarship for needy families amidst the pandemic and its restriction measures were proposed and adapted to help people cope with the unprecedented situation. Likewise, to prevent students from losing an academic year of education and to help them keep engaged with learning, methods such as e-learning, online or virtual learning were introduced and implemented by numerous universities and institutions across the globe [3].

E-learning or electronic learning is a form of learning that employs the use of internet, information, communication and technology (ICT), and web-based technology to obtain and transfer information as well as knowledge virtually using multiple electronic mediums [4]. The intent of e-learning was to allow students continue their regular educational routine, to engage them in active learning, help prevent the loss of an academic year due to months of permanent lockdown and to ease some of the stress and anxiety due to the COVID-19 pandemic. Online learning/e-learning focuses on helping students evolve a self-driven and self-directed problem-solving skilled approach as compared to traditional face-to-face learning [5]. Although switching to online learning was widely and significantly practiced during the peak of pandemic, however, true effectiveness and course completion rate was not satisfactorily achieved. The online mode was also observed to have insufficient implementation [6, 7]. Lack of one-on-one discussion with peers and teachers to exchange ideas, views, information and queries, high cost associated with purchase of computers, laptops or smart-phones, inadequate knowledge to fully utilize the software and advanced, complicated technology were some of the limitations associated with virtual learning [8].

Educational systems around the world largely constitute of traditional face-to-face lectures, interactive small group discussion sessions, simulated train-

ing courses, and clinical skill learning in practical and out-patient departments all of which require close contact with facilitators, peers and patients to exchange and receive firsthand information and knowledge [9]. Although e-learning is used as a supplementary form of education dating back to 1990 in more advanced countries, the characteristics and benefits accomplished with face-to-face traditional/physical education has been unparalleled [10].

Pakistan, like other developing countries, also implemented strict lockdown measures to overcome the severity of the infection and propagation of COVID-19. Educational activities throughout Pakistan were halted for some time. Although internet resources and latest technologies were sufficiently available in developed countries and were being utilized to benefit their students, its advantages were not satisfactorily attained in Pakistan [11]. Scarce accessibility to reliable, economical and fast internet connectivity, obstructed and frequently hampered the virtual learning process especially for students residing in rural areas and deprived communities of Pakistan [11]. Frequent prolonged durations of power failures (electricity load shedding) in rural as well as urban areas added with teachers and students' limitation towards technology and software dexterity also heaped the difficulties [12].

Several previously conducted studies in Pakistan have only assessed the students' perception and the challenges faced with the online/virtual teaching method [11–15]. However, none of the research conducted in Pakistan has compared the knowledge and skills of undergraduate students using conventional and online learning methods in a particular course. Hence, the present study aims to (i) analyze dental students' understanding regarding the Oral Biology course by assessing their knowledge and skills between the students enrolled during 2020 and 2021 (ii) evaluate the perception of dental students regarding the virtual mode of teaching.

2. Materials and methods

This research was conducted among dental students enrolled at a dental college from September 2021 to November 2021. Institutional ethical approval was obtained from the local Ethical Review Committee (Estb/wmdc/2022/236). The study was executed as per the Declaration of Helsinki.

2.1. Study procedure

This was a quasi-experimental study in which findings of retrospective group of first year BDS undergraduate students enrolled during the 2020 academic year were compared with a prospective experimental group enrolled during 2021. Convenient sampling technique was used in which all students enrolled in Oral Biology course were included. Oral biology is a one-year course that has been further subdivided into three modules. Each module comprises various topics related to oral biology.

Students enrolled during 2020 were initially taught via the traditional way of face-to-face teaching, however due to the sudden closure of all educational institutes in March 2020, all teaching for nearly the entire year was continued online. However, the exams were held on campus. For the students enrolled during 2020, previously recorded data that assessed student's perception regarding the online mode of teaching and the Oral Biology course was used for the current research. For students registered in 2021, the mode of teaching was traditional but due to the rise of COVID-19 again in 2021 there was a 4-week lockdown which resulted in the transition towards online education, but for clarity purpose they have been classified as the traditional group. The latter group's perception was evaluated from September to November 2021.

The teaching for the Oral Biology course was conducted in the form of large group sessions using PowerPoint presentations alongside practical demonstration. Small group sessions were conducted for which learning objectives were given out earlier. Lab-based sessions were carried out on various topics in oral histology. Both classes (years 2020 and 2021) were taught by the same tutors and used the same educational content.

2.2. Outcome assessment

Results from second module were assessed for both groups. This comprised of both theoretical and practical components. For the theoretical part, the single best choice (BCQs) and short answer questions (SAQs) marks were considered, while for the practical component objective structured practical examinations (OSPE) and viva marks were incorporated. The level of knowledge for the students of both groups was assessed by adding the marks of BCQs and SAQs. Skills acquired by the students were eval-

uated by combining the marks obtained from OSCE and VIVA examination. For both groups, students received the same type of evaluation methods and questions.

2.3. Questionnaire

A questionnaire was also distributed to the participants that aimed to evaluate students' perception regarding the online mode of teaching. The questionnaire comprised of demographic details, which included age, gender, and year of study. The subsequent section was further subdivided into preference, effectiveness and learning satisfaction domain, each comprising of assessing student's perception regarding online teaching. The reliability of the questionnaire was assessed by Cronbach's Alpha coefficient and was found to be good with a mean value of 0.844 in all domains.

2.4. Statistical analysis

Statistical Package for Social Sciences version 23 (IBM Corp., Armonk, NY, USA) was used to process and analyze the data. Normality was assessed by Shapiro Wilk test. Categorical data was expressed as frequency and percentages while continuous variables were expressed as mean and standard deviation (SD). Cronbach's Alpha was used to estimate the reliability of the questionnaire's domains. Mann-Whitney U test was used to compare the grades between the two batches and Spearman's correlation coefficients assessed the correlation of multiple variables with each other.

3. Results

A total of 98 students of a private dental college, comprising of $n = 31$ (31.6%) males and $n = 67$ (68.3%) females with a mean age of 20.7 years participated in the study. Forty-two (42) students enrolled in batch 2020 followed the virtual/online learning, while 56 students of batch 2021 followed the traditional/face-to-face learning system (Table 1).

Descriptive scores of Preference, Effectiveness and Learning Satisfaction domains based on Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) are presented in Table 2. The mean score of the three domains were found to be 2.56, 2.31 and 2.10 respectively. The majority of students (50%) agreed that

Table 1
Demographic characteristics of participants

Participant characteristics	Batch of 2020	Batch of 2021	Total
	(online/virtual/distance learning)	(traditional learning)	
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Age	21.23 \pm 1.15	20.0 \pm 1.15	20.70 \pm 1.30
Gender			
	Mean (n) (%)	Mean (n) (%)	Mean (n) (%)
Male	20 (35.7%)	11 (26.2%)	31 (31.6%)
Female	36 (64.3%)	31 (73.8%)	67 (67.7%)
Total no. of participants	56 (57.1%)	42 (42.8%)	

Descriptive statistics, frequency. SD = Standard deviation, n = Sample size.

they understood the concepts taught during online classes, while 69.6% of online learning group agreed that their queries were suitably answered. Regarding effectiveness, about 53.6% students of online group expressed that online learning was stressful, but they did have time to prepare and review learning material (46.4%). More than 50% of the traditional learning group however agreed with the same. Learning satisfaction was considered unsatisfactory by the online learning group. About 50% of traditional learning and 43% of online learning students disagreed that online learning provided learning satisfaction similar to face-to-face learning. Eagerness to prepare learning material, likeness toward online learning, ease of communication, effectiveness and stimulation were all disagreed by the online learner group.

A comparison between grade scores of the online and traditional learning groups reported a statistically significant difference ($p = 0.05^*$) regarding the Short Answer Question Types, viva or verbal questions ($p = 0.016^*$) and overall attendance ($p = <0.001^*$) of the students (Table 3).

Correlation between the variables of preference, effectiveness and learning satisfaction domains are depicted in Table 4. Strong correlations were observed via the multivariable analysis. All correlations were statistically significant at $p < 0.01$ level (Table 4).

4. Discussion

The spread of COVID-19 has led to the unprecedented institutes' closure, which affected many students worldwide. Abrupt transformation of teaching from traditional to virtual mode was conducted in order to continue academic teaching online and reduce the close gathering of students in classrooms in order to prevent the spread of infection.

This retrospective experimental study was conducted to compare the understanding of the Oral Biology course taught to undergraduate dental students enrolled during 2020 and 2021 through traditional and virtual mode and to assess the perceptions of students in both groups regarding online learning.

Digital technology played a significant role in the continuation of dental education despite the ongoing COVID-19 pandemic. It has been identified from the current study that most students studying on campus stated finding it easy to understand the concept taught related to oral biology, while about 43% of the students taught online found it difficult to understand. These findings disagree with the study conducted by Amir et al., where more than 50% students showed positive attitude towards online learning and education [16]. This can be attributed to the fact that students of batch 2020 had recently been inducted to dental school when the COVID-19 pandemic emerged resulting in the dramatic closure of institutes and transition to online education. First time exposure to the difficult field of dental education that required through understanding of concepts was therefore not met to complete content of majority of students.

Most dental students studying both the traditional and virtual mode of teaching agreed that all their questions were suitably answered during the sessions. These findings are in agreement with the previously conducted research [17]. Similarly, students also responded positively regarding the mode of test because during online session in 2020, time-restricted BCQs and SAQ-based theoretical tests were held online, which students found easier to do while sitting at the comfort of their home.

Virtual learning is quite different from traditional learning, as it necessitates certain requirements for its successful conduction. Based on this, presence of adequate internet connection, electricity and avail-

Table 2
Descriptive statistics score of different domains

Domains	Likert scale																Mean score of each domain variable		Mean domain scores ± SD	
	Strongly disagree				Disagree				Agree				Strongly agree							
	2020		2021		2020		2021		2020		2021		2020		2021		2020	2021	2020	2021
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%				
Preference domain																				
Students understanding the concept taught in session	10	(17.9)	7	(16.7)	24	(42.9)	13	(31)	20	(35.7)	21	(50)	2	(3.6)	1	(2.4)	2.25 ± 0.79	2.38 ± 0.79	2.59 ± 0.74	2.57 ± 0.87
Queries of students were suitably answered during sessions	4	(7.1)	6	(14.3)	8	(14.3)	2	(4.8)	39	(69.6)	28	(66.7)	5	(8.9)	6	(14.3)	2.80 ± 0.69	2.81 ± 0.86		
Test method was satisfactorily assessed	4	(7.1)	8	(19)	13	(23.2)	9	(21.4)	33	(58.9)	20	(47.6)	6	(10.7)	5	(11.9)	2.73 ± 0.75	2.52 ± 0.94		
Effectiveness domain																				
Students experienced no problem during learning sessions	17	(30.4)	11	(26.2)	21	(37.5)	18	(42.9)	14	(25)	12	(28.6)	4	(7.1)	1	(2.4)	2.08 ± 0.92	2.07 ± 0.81	2.30 ± 0.82	2.36 ± 0.81
Students were not stressed during the sessions	11	(19.6)	4	(9.5)	30	(53.6)	20	(47.6)	11	(19.6)	15	(35.7)	4	(7.1)	3	(7.1)	2.14 ± 0.82	2.40 ± 0.76		
Students had to prepare learning material for class	6	(10.7)	7	(16.7)	20	(35.7)	10	(23.8)	27	(48.2)	23	(54.8)	3	(5.4)	2	(4.8)	2.48 ± 0.76	2.48 ± 0.83		
Students had time to review learning material	6	(10.7)	7	(16.7)	21	(37.5)	10	(23.8)	25	(44.6)	23	(54.8)	4	(7.1)	2	(4.8)	2.48 ± 0.78	2.47 ± 0.83		
Learning satisfaction domain																				
Students had similar satisfaction with online and traditional learning	19	(33.9)	9	(21.4)	24	(42.9)	21	(50)	8	(14.3)	9	(21.4)	5	(8.9)	2	(4.8)	1.98 ± 0.92	2.83 ± 4.83	2.03 ± 0.90	2.38 ± 1.66
Online learning maybe implemented in next session	20	(35.7)	11	(26.2)	21	(37.5)	19	(45.2)	10	(17.9)	9	(21.4)	5	(8.9)	3	(7.1)	2.00 ± 0.95	2.09 ± 0.88		
Online learning gives motivation for self directed learning	17	(30.4)	7	(16.7)	21	(37.5)	16	(38.1)	12	(21.4)	16	(38.1)	6	(10.7)	3	(7.1)	2.12 ± 0.97	2.36 ± 0.85		
Students were eager to prepare learning material before start of online sessions	13	(23.2)	11	(26.2)	27	(48.2)	11	(26.2)	13	(23.2)	18	(42.9)	3	(5.4)	2	(4.8)	2.11 ± 0.82	2.26 ± 0.91		
Communication was easier	16	(28.6)	8	(19)	30	(53.6)	12	(28.6)	6	(10.7)	20	(47.6)	4	(7.1)	2	(4.8)	1.96 ± 0.83	2.38 ± 0.85		

Descriptive statistics, SD = Standard deviation. Cronbach's Alpha coefficient = 0.844.

Table 3
Comparison between the theoretical and practical grade scores of online learning and traditional learning groups

Variables	Year 2020 online group		Year 2021 traditional group		P-value
	Mean rank	Mean scores \pm SD	Mean rank	Mean scores \pm SD	
	SAQs marks obtained	54.35	27.07 \pm 12.07	43.04	
BCQs marks obtained	50.38	18.44 \pm 9.18	48.33	18.52 \pm 6.60	0.725
Knowledge	50.82	45.55 \pm 20.10	47.74	46.19 \pm 15.19	0.595
OSPE marks obtained	49.13	26.21 \pm 10.77	49.99	27.16 \pm 12.06	0.883
VIVA marks obtained	55.46	22.39 \pm 9.68	41.55	20.83 \pm 6.76	0.016*
Skill	52.04	48.78 \pm 19.90	44.84	47.83 \pm 15.15	0.213
Attendance	35.47	63.16 \pm 21.09	68.20	84.24 \pm 18.05	<0.001*

Mann-Whitney U test applied, statistically significant p -value = <0.05*. Descriptive statistics = mean \pm SD = Standard deviation.

ability of software are imperative [6, 18]. Students studying online found it difficult to comprehend online learning and stated being stressed. These findings are similar to previously conducted research [16, 18]. This can be due to difficulties experienced by dental students in terms on internet connection, electricity issues in remote areas and high cost of laptops.

Most of the students from both groups stated that they were able to prepare for learning material and reviewed it before the sessions. These findings are in agreement with Amir et al., where students did not prefer virtual learning, but were still motivated enough to prepare the study materials [17].

Results from the current study identified that students from both groups were unsatisfied with the virtual mode of teaching. Previously conducted research differed from our study because their students had adequate knowledge regarding the latest technology and continued their study with ease, and displayed greater satisfaction [20, 21]. Hence, students must be updated with the latest technology to acquire desired results for effective learning.

Students from traditional and virtual groups both found online teaching difficult. These findings are in agreement with the study conducted by Sarwar et al., where most of the students expressed dissatisfaction regarding online classes proving useful [14]. Similarly, online learning over traditional modes of teaching was also not preferred by both batches of students. These findings are consistent with the previously conducted survey, where students preferred face-to-face teaching [14, 22–24]. Therefore, to improve the efficiency of the student's long duration sessions must be shorted and adequate breaks must be given between two sessions. This will not only help reduce the mental load but also at the same time reduce the physical stress instigated due to long use of electronic devices.

In the current study, the teaching method had no influence on knowledge and learning of dental students registered in the Oral Biology course. Statistically significant association was seen among the marks scored by students of both groups assessing the theoretical knowledge using SAQs (p - 0.05*). Similarly, significant association was noted with skills component, assessed in form of viva (p - 0.016*). These results are comparable with previously conducted research [4]. However, our results differed considerably from an Iranian study where higher score in knowledge was obtained by students studying online as compared to the conventional method [25].

Statistically significant correlations at $p < 0.01$ * were observed among multiple domains when compared with each other depicting the impact each variable had on the other. Our results contrast with an earlier conducted research where strong correlations were observed only among time, efficiency and motivation variables [17].

A few limitations can be identified from the current study. This was a single-centric research with a limited sample size and only knowledge and skills for one course were compared. This restrained the generalization of results. Very few studies have been conducted that have evaluated the association between the scores obtained by the students taught either virtual and traditionally and assessed their perception, hence more studies in this regards are encouraged.

5. Conclusion

Despite the disruption educational sector had to face due to the COVID-19 pandemic, most of the students preferred face-to-face teaching over online

Table 4
Association (Spearman's correlation) between the domains scores

	Under-standable	Effective	Suitably assessed	Problem-free	Stress-free	Self-learning encouraged	Time managed	Satisfactory	Implementable	Motivates	Self-motivated	Communicable	Preferable	Effective learning	Stimulates
Understandable	1														
Effectiveness	0.485**	1													
Suitably assessed	0.542**	0.586**	1												
Problem-free	0.541**	0.242*	0.446**	1											
Stress-free	0.260**	-0.005	0.118	0.409**	1										
Self-learning encouraged	0.494**	0.382**	0.503**	0.568**	0.386**	1									
Time managed	0.425**	0.308**	0.357**	0.473**	0.484**	0.716**	1								
Satisfactory	0.381**	0.137	0.225*	0.581**	0.482**	0.369**	0.500**	1							
Implementable	0.477**	0.122	0.292**	0.595**	0.415**	0.474**	0.429**	0.786**	1						
Motivates	0.429**	0.123	0.274**	0.518**	0.512**	0.456**	0.434**	0.769**	0.757**	1					
Self-motivated	0.468**	0.318**	0.306**	0.494**	0.313**	0.550**	0.521**	0.605**	0.536**	0.660**	1				
Communicable	0.496**	0.312**	0.356**	0.457**	0.291**	0.450**	0.406**	0.590**	0.546**	0.647**	0.676**	1			
Preferable	0.407**	0.161	0.320**	0.576**	0.326**	0.475**	0.433**	0.548**	0.649**	0.606**	0.564**	0.586**	1		
Effective learning	0.495**	0.199*	0.350**	0.518**	0.356**	0.420**	0.458**	0.637**	0.672**	0.647**	0.615**	0.725**	0.802**	1	
Stimulates	0.547**	0.281**	0.342**	0.628**	0.343**	0.460**	0.448**	0.633**	0.647**	0.591**	0.615**	0.670**	0.768**	0.849**	1

** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed).

learning as the majority found it stressful and was quite unsatisfied. However, grades in theoretical and verbal exams significantly improved in virtual learning groups as compared to the traditional learning group.

Conflict of interest

No conflict of interest related to this manuscript has been reported.

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Ethical approval

Institutional ethical approval was obtained from the local Ethical Review Committee (Estb/wmdc/2022/236).

Informed consent

All participants were informed regarding the study design and provided written consent forms.

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