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Original Article

Online courses for dentist continuing education: A new trend after the COVID-19 pandemic

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Abstract *Background/purpose:* Online courses have been widely used in all levels of education during the COVID-19 pandemic. This study explored the effectiveness of a dentist continuing education (DCE) course through the online devices in Taiwan.
Materials and methods: The practicing dentists who participated in the online course of dental radiation technology for DCE offered by the Taiwan Dental Association (TWDA) in October 2022

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Dentists;
Urban-rural gap

and in March 2023 were enrolled in this study. The composition of participating dentists was confirmed by the public inquiry system and their learning effectiveness was evaluated by a questionnaire-based survey after the online DCE class.
Results: All participating dentists (132 in October 2022 and 117 in March 2023) obtained consistent good learning outcomes in this online DCE course. Of these 249 dentists, there were 170 (68.27%) males and 79 (31.73%) females, 127 (51.00%) dental specialists and 122 (49.00%) general dentists, as well as 50 (20.08%) hospital dentists and 199 (79.92%) clinic dentists. The participation rates for this course of practicing dentists in non-municipalities (4.70%), counties (3.88%), eastern region (8.08%), and outlying islands (3.60%) were much higher than those in municipalities (0.79%), cities (1.16%), and the western region including the northern region (0.88%), central region (1.96%), and southern region (1.94%), respectively.
Conclusion: The participating dentists express positive feedback on the online DCE courses, and the online DCE courses can reduce the urban-rural gap in dental education resources. The use of online DCE courses in dental education will be a future trend.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic caused by a severe acute respiratory disease coronavirus 2 (SARS-CoV-2) is a highly contagious disease that has a major impact on health through pneumonia or organ injuries. Due to highly contagious property of this virus through both direct contact and air droplets, the abrupt outbreak of the COVID-19 pandemic has not only violated global economic and social activities, but also changed our lifestyle in many aspects.[1—3] To reduce the risk of virus infection due to physical contacts, the online class or online meeting was then extensively applied to school education to prevent the spread of COVID-19. Undoubtedly, dental education has no exception in this trend.[4] The online class could be regarded as using the online devices to conduct a course either synchronously or asynchronously. Although the concept of online learning has been adopted into education for a long time, it has been widely used in all levels of education during the COVID-19 pandemic.[5] Previous studies in the United States and Taiwan evaluated the effectiveness of online courses for their undergraduate dental students during the COVID-19 pandemic. Their results showed that the online courses are well accepted by their students and the conclusion suggests to continue the online courses after the COVID-19 pandemic.[6,7]

The significance of online teaching and learning is not only to reduce the physical contacts during the pandemic, but more importantly, it breaks through geographical and time constraints in education, and students can carry out learning activities at any place and at any time. However, the policy has been gradually relaxed to allow compromised social activities and physical contacts as the COVID-19 pandemic gradually eased. Schools that conducted the online courses only during the outbreak of the COVID-19 pandemic before are now resumed implementing the physical class. Even though the COVID-19 pandemic gradually eased, the Taiwan Dental Association (TWDA) designed a 3-h online course of dental radiation technology for dentist continuing education (DCE) for the first time in October 2022. The participating dentists responded well after the class. In March 2023, the TWDA conducted this online course for the second time.[8] The main purpose of this DCE course design was not only to reduce the physical contacts, but also to promote the opportunities for all dentists in Taiwan to participate in the DCE through the online course that was not restricted by geography. Therefore, in addition to the online course, the theme of the course was dental radiation technology, which was suitable for all types of dentists, and was also suitable for participation by dentists of various specialties and dentists from any regions of Taiwan.

Previous studies focused more on the learning effectiveness of dental students for school courses through the online devices. However, there were fewer studies on the online DCE courses. In addition to evaluating the learning effectiveness of dentists participating in the online DCE courses, this study also analyzed the composition of participating dentists, including their gender, specialty, practice form, and geographical distribution. The above information could be obtained from the public medical personnel practice registration inquiry system of the Ministry of Health and Welfare. The results can help us to understand the role and advantages of the online DCE courses more comprehensively, and will serve as a reference for the implementation of the DCE policy in the future.

Materials and methods

Participants

All dentists who participated in the online course of dental radiation technology for DCE in October 2022 and in March 2023 were included in this study. Their gender, specialist qualification, dental institutions (hospitals or dental

clinics), and practice registration place (or working place) were confirmed by the public inquiry system and were used as the basis for grouping of the participating dentists. In addition, the numbers of in-service dentists nationwide by cities and counties in October 2022 and in March 2023 were obtained from the public information of the TWDA.

Teaching process

This DCE course was a specific 3-h online course of dental radiation technology for in-service dentists and was performed in the form of lectures. It was offered free of charge to the TWDA member dentists nationwide for the DCE. Dental radiation technology was chosen as the theme of this online DCE course because it was the common clinical skill for all dentists. The course content included the principles and techniques of dental radiography. A senior medical radiation technologist in the Department of Dentistry of National Taiwan University Hospital (NTUH) mainly used actual radiographic images and clinical photographs to conduct the teaching of this DCE course. All dentists who registered in this course would receive an online course link sent by the TWDA through the email before the class, and all dentists who participated in this course would also receive an online questionnaire link after the DCE class. There were 5 quiz questions and one open question. The quiz questions were multiple choice questions with four options to evaluate the learning outcomes of the participating dentists, while the participants could fill any suggestion and/or opinion (including advantage or disadvantage) in the open question.

Statistical analysis

All data obtained from the participating dentists were stored in excel files and used for statistical analysis. The differences in the mean scores of the quiz were compared between two groups of the participating dentists in October 2022 and in March 2023 by independent sample *t*-test. The result was considered to be significant if the *P*-value was less than 0.05.

Results

Participants

There were 161 and 163 dentists who registered the online course of dental radiation technology in October 2022 and in March 2023, respectively (Table 1). The numbers of dentists who actually participated in this course were 134 and 119, respectively. The attendance rates were 83.23% (134/161) and 73.01% (119/163), respectively. Furthermore, the numbers of dentists who completed the questionnaire were 132 and 117, respectively. The valid response rates were 98.51% (132/134) and 98.32% (117/119), respectively. In overall, of the 324 dentists who registered this course, 253 actually participated in this course with an attendance rate of 78.09% (253/324). Furthermore, 249 dentists completed the questionnaire with a valid response rate of 98.42% (249/253) (Table 1).

Learning effectiveness of the participating dentists

There were 5 quiz questions for evaluating the learning effectiveness of participating dentists in this online DCE course of dental radiation technology (Table 2). These quiz questions were the same in October 2022 and in March 2023. The quiz questions focused on the principles and techniques of dental radiography, and the comprehensive concept about dental radiography. The numbers (proportions) of participating dentists who answered each question correctly were between 111 (84.09%) and 126 (95.45%) in October 2022, and between 101 (86.32%) and 110 (94.02%) in March 2023, respectively. Although the correct rate of question focused on the comprehensive concept was slightly lower, the correct rates of all questions reached about 90%, indicating that most participating dentists have obtained good learning outcomes from the course. Furthermore, the mean score of correct answers for all participating dentists were 4.54 in October 2022 and 4.47 in March 2023, respectively. There was no significant difference in the mean score between the two groups, indicating that the participating dentists of these two DCE courses all obtained consistent good learning outcomes (Table 2).

Open question

The free comments from the participating dentists for the open question could be summarized as follows in a descending order by (1) positive emotions towards this online course; (2) suggestion to continue this online course or to add advanced courses such as the application of cone-beam computed tomography (CBCT) in dentistry; (3) this course was practical or helpful f or the clinical dental work; (4) to request the course materials; (5) response to the

Table 1 Numbers of dentists who registered and participated in the online course of dental radiation technology for dentist continuing education (DCE) offered by the Taiwan Dental Association (TWDA), as well as those who completed the quiz after the course in October 2022 and in March 2023.

	October 2022	March 2023	Overall
Number of dentists who registered the course	161	163	324
Number of dentists who participated in the course	134	119	253
Attendance rate	83.23% (134/161)	73.01% (119/163)	78.09% (253/324)
Number of dentists who completed the questionnaire	132	117	249
Valid response rate	98.51% (132/134)	98.32% (117/119)	98.42% (249/253)

Table 2 Question content and question focus used in the quiz of the online course of dental radiation technology for dentist continuing education (DCE) offered by the Taiwan Dental Association (TWDA) in October 2022 and in March 2023 and the quiz results.

Question content (multiple choice)	Number (proportion) of dentists who answered this question correctly		Question focus Correct answer
	October 2022	March 2023	
1. Which of the following can reduce the effect of image magnification? A. To use a short cone B. To use a long cone C. To reduce the focal spot to skin distance D. To increase the receptor to object distance	121/132 (91.67%)	102/117 (87.18%)	Radiographic principle B
2. Which of the following are the functions of the identification dot (or the English letter) on the radiographic film? When irradiating, the dot ①towards the X-ray tube ②back to the X-ray tube ③close to the occlusal surface ④away from the occlusal surface A. ①③ B. ①④ C. ②③ D. ②④	122/132 (92.42%)	110/117 (94.02%)	Radiographic principle A
3. Which of the following is the most ideal dental radiographic technique to avoid the shadowing of zygomatic bone when observing the apical lesion of the maxillary molars? A. Bisecting angle technique B. Bite-wing film technique C. Paralleling technique D. Occlusal film technique	119/132 (90.15%)	103/117 (88.03%)	Radiographic technique C
4. Which one is wrong in the description of panoramic radiography? A. The patient's Frankfort horizontal plane is parallel to the ground B. The upper and lower incisors of patient bite in the groove of machine C. To fix the head with a head clip to prevent the patient from shaking during irradiating D. To put the thyroid collar on the patient	126/132 (95.45%)	107/117 (91.45%)	Radiographic technique D
5. What kind of distorted image will be caused if the patient's head is raised too high during the positioning of panoramic radiography? A. The occlusal plane presents an inverted V shape, and the hard palate overlaps with the root apex of upper teeth B. Excessive magnification in the horizontal direction of lower incisors C. The image of anterior teeth is narrow and unclear D. The anatomical structure in the image is wide on one side and narrow on the other	111/132 (84.09%)	101/117 (86.32%)	Comprehensive concept A
Overall test results	Mean score ± SD		Significance
	October 2022	March 2023	*t*-test
Mean number of correct answers for all participants	4.54 ± 0.72	4.47 ± 0.80	$P = 0.242$

problems of network equipment and technology; (6) the online course was beneficial for rural dentists to participate in the DCE; (7) suggestion to offer this online course to dental assistants; (8) suggestion to make this course content into a standardized course for the usage in asynchronous learning (Table 3). In overall, the number of participating dentists who answered the open question was 93 with a response rate of 36.76% (93/253). Among them, the vast majority (80.65%, 75/93) expressed positive emotions towards this online DCE course (Table 3).

Composition of the participating dentists

The were 132 and 117 participating dentists completed the questionnaire after the DCE class in October 2022 and in March 2023, respectively, with a total of 249 participating dentists (Table 4). Of these 249 dentists, there were 170 (68.27%) males and 79 (31.73%) females. For specialist qualification, there were 127 (51.00%) dental specialists and 122 (49.00%) general dentists. Of the 127 dental specialists, 80 (32.13%) had one specialty, 44 (17.67%) had 2 specialties, and 3 (1.20%) had 3 specialties. Regarding the working dental institutions, there were 50 (20.08%) hospital dentists and 199 (79.92%) clinic dentists. Of the 50 hospital dentists, 17 (6.83%) were in medical centers, 24 (9.64%) in regional hospitals, and 9 (3.61%) in district hospitals (Table 4).

Furthermore, there were totally 177 specialist qualifications for the 127 dental specialists (Table 5). Among the current 10 dental specialties in Taiwan, the largest number of dental specialists participating in this course was family dentistry (91, 51.41%), followed in a descending order by special needs dentistry (43, 24.29%), orthodontics (10, 5.65%), periodontics (8, 4.52%), oral and maxillofacial surgery (7, 3.95%), endodontics (5, 2.82%), prosthodontics (5, 2.82%), pediatric dentistry (4, 2.26%), oral pathology (3, 1.69%), and operative dentistry (1, 0.56%) (Table 5).

Geographical distribution of the participating dentists

In overall, the average number of practicing dentists in Taiwan (excluding Lienchiang County) was 16,158.5 in October 2022 and in March 2023 (Table 6). Taipei City was the city with the largest number of practicing dentists (3560, 22.03%), and Kinmen County was the county with the smallest number of practicing dentists (19.5, 0.12%) among all cities and counties in Taiwan, respectively (Table 6). The total number of dentists participating in this online DCE course in October 2022 (132 dentists) and in March 2023 (117 dentists) was 249. Taichung City was the city with the largest number of participating dentists (37, 14.86%) and Hsinchu County was the county with the smallest number of participating dentists (1, 0.40%) among all cities and counties in Taiwan, respectively. Moreover, Penghu County and Lienchiang County had none of participating dentists. Furthermore, the numbers of participating dentists and practicing dentists were used as the numerator and denominator, respectively, to calculate the participation rate of this online DCE course. The overall participation rate in

Table 3 Overall feelings about the online course of dental radiation technology and suggestions for the open question by participating dentists.

Responses for the open question	October 2022	March 2023	Overall
Number of participating dentists who answered the open question	48	45	93
Response rate	35.82% (48/134)	37.82% (45/119)	36.76% (93/253)
Number (proportion) of opinions for the open question[a]			
Positive emotions towards this online course	39 (66.10%)	36 (69.23%)	75 (67.57%)
Suggestion to continue this online course or to add advanced courses such as the application of cone-beam computed tomography (CBCT) in dentistry	5 (8.47%)	9 (17.31%)	14 (12.61%)
This course was practical or helpful in clinical dental work.	7 (11.86%)	3 (5.77%)	10 (9.01%)
To request course materials	2 (3.39%)	1 (1.92%)	3 (2.70%)
Response to the problems of network equipment and technology	3 (5.08%)	0	3 (2.70%)
The online course was beneficial for rural dentists to participate in the dentist continuing education (DCE).	2 (3.39%)	1 (1.92%)	3 (2.70%)
Suggestion to offer this online course to dental assistants	1 (1.69%)	1 (1.92%)	2 (1.80%)
Suggestion to make this course content into a standardized course for the usage in asynchronous learning	0	1 (1.92%)	1 (0.90%)
Total number of opinions	59 (100%)	52 (100%)	111 (100%)

[a] Some participating dentists put forward 2 or more opinions.

Table 4 Composition of dentists who participated in the online course of dental radiation technology for dentist continuing education (DCE) offered by the Taiwan Dental Association (TWDA) and those who completed the quiz after the course in October 2022 and in March 2023.

Category	Number (proportion) of dentists		
	October 2022	March 2023	Overall
Gender			
Male	91 (68.94%)	79 (67.52%)	170 (68.27%)
Female	41 (31.06%)	38 (32.48%)	79 (31.73%)
Specialist qualification			
Dental specialists	70 (53.03%)	57 (48.72%)	127 (51.00%)
With one specialty	42 (31.82%)	38 (32.48%)	80 (32.13%)
With 2 specialties	27 (20.45%)	17 (14.53%)	44 (17.67%)
With 3 specialties	1 (0.76%)	2 (1.71%)	3 (1.20%)
General dentists	62 (46.97%)	60 (51.28%)	122 (49.00%)
Dental institutions			
Hospitals	25 (18.94%)	25 (21.37%)	50 (20.08%)
Medical centers	10 (7.58%)	7 (5.98%)	17 (6.83%)
Regional hospitals	11 (8.33%)	13 (11.11%)	24 (9.64%)
District hospitals	4 (3.03%)	5 (4.27%)	9 (3.61%)
Dental clinics	107 (81.06%)	92 (78.63%)	199 (79.92%)
Overall	132 (100%)	117 (100%)	249 (100%)

Taiwan was 1.54%. Taitung County was the county with the largest participation rate (25.00%), and Taoyuan City was the city with the smallest participation rate (0.21%) among all cities and counties in Taiwan, respectively (Table 6).

Comparison of regional distribution of the participating dentists

The regional distribution of the participating dentists and the practicing dentists could be compared between municipalities and non-municipalities, between cities and counties, and among different regions of Taiwan (Table 7). In overall, the number of practicing dentists in municipalities (13,050.5, 80.77%) was higher than that in non-municipalities (3108, 19.23%). However, the number of participating dentists in non-municipalities (146, 58.63%) was higher than that in municipalities (103, 41.37%). The participation rate of non-municipalities (4.70%) was much higher than that of municipalities (0.79%). Although both the numbers of practicing dentists (13,888, 85.95%) and participating dentists (161, 64.66%) in cities were higher than those in counties (2270.5, 14.05% and 88, 35.34%, respectively), the participation rate of counties (3.88%) was much higher than that of cities (1.16%) (Table 7). Furthermore, the numbers of practicing dentists in the northern (8656, 53.57%), central (3257.5, 20.16%), and southern (3768.5, 23.32%) regions of Taiwan were much higher than those in the eastern region (421, 2.61%) and outlying islands (55.5, 0.34%) of Taiwan. The numbers of participating dentists in the northern (76, 30.52%), central (64, 25.70%), and southern (73, 29.32%) regions of Taiwan were also higher than those in eastern region (34, 13.65%) and outlying islands (2, 0.80%) of Taiwan. However, among all regions of Taiwan, the highest participation rate was in the eastern region (8.08%), followed in a descending order by the outlying islands (3.60%), central region (1.96%), southern region (1.94%), and northern region (0.88%) (Table 7).

Discussion

In 2001, Taiwan revised the Physicians Act and added this provision: Practicing physicians shall receive continuing education and submit documentary proof of completed continuing education every six years in order to renew their practice license. Furthermore, in Taiwan's Physicians Act, medical professions in the role of clinicians include physicians, doctors of Chinese medicine, and dentists. According to the relevant regulations, practicing physicians currently need to complete 120 points of continuing education courses every six years (usually one point for 1 h of participating in government-approved courses). For dentists, this is the so-called dentist continuing education (DCE) courses and dentists also need to complete the minimum requirement of continuing education points (120 points).

Many social activities (including educational activities of physical classes) were canceled after the COVID-19 pandemic broke out at the end of 2019. The government extended the deadline for the renewal of the practice license of medical professions as a flexible measure. However, educational activities cannot be stopped indefinitely. Therefore, in Taiwan, schools at all levels use the online classes as a method to continue the educational activities including those carried out in dental schools, and all of these educational activities have achieved good results.[4,7] Recently, due to the end of the COVID-19 pandemic, research articles have begun to discuss the effectiveness of online courses of dental schools and whether these online courses need to continue after the pandemic.[6,7] In fact, during the COVID-19 pandemic, a large number of DCE courses were also conducted online. However, the effectiveness of the online DCE courses has rarely been discussed.

Although the time has come to the end of the COVID-19 pandemic, the TWDA tried to provide the online DCE course

Table 5 Specialty distribution of dental specialists who participated in the online course of dental radiation technology for dentist continuing education (DCE) offered by the Taiwan Dental Association (TWDA) and those who completed the quiz after the course in October 2022 and in March 2023.

Number (proportion) of specialty qualifications	October 2022				March 2023				Overall
	One specialty	2 specialties	3 specialties	Total	One specialty	2 specialties	3 specialties	Total	
Oral and maxillofacial surgery	2 (2.02%)	2 (2.02%)	0	4 (4.04%)	2 (2.56%)	1 (1.28%)	0	3 (3.85%)	7 (3.95%)
Oral pathology	0	2 (2.02%)	0	2 (2.02%)	0	1 (1.28%)	0	1 (1.28%)	3 (1.69%)
Orthodontics	1 (1.01%)	4 (4.04%)	0	5 (5.05%)	2 (2.56%)	2 (2.56%)	1 (1.28%)	5 (6.41%)	10 (5.65%)
Pediatric dentistry	0	2 (2.02%)	0	2 (2.02%)	1 (1.28%)	1 (1.28%)	0	2 (2.56%)	4 (2.26%)
Endodontics	2 (2.02%)	1 (1.01%)	0	3 (3.03%)	1 (1.28%)	1 (1.28%)	0	2 (2.56%)	5 (2.82%)
Prosthodontics	1 (1.01%)	2 (2.02%)	0	3 (3.03%)	1 (1.28%)	1 (1.28%)	0	2 (2.56%)	5 (2.82%)
Operative dentistry	0	1 (1.01%)	0	1 (1.01%)	0	0	0	0	1 (0.56%)
Periodontics	4 (4.04%)	1 (1.01%)	1 (1.01%)	6 (6.06%)	0	1 (1.28%)	1 (1.28%)	2 (2.56%)	8 (4.52%)
Family dentistry	24 (24.24%)	23 (23.23%)	1 (1.01%)	48 (48.48%)	25 (32.05%)	16 (20.51%)	2 (2.56%)	43 (55.13%)	91 (51.41%)
Special needs dentistry	8 (8.08%)	16 (16.16%)	1 (1.01%)	25 (25.25%)	6 (7.69%)	10 (12.82%)	2 (2.56%)	18 (23.08%)	43 (24.29%)
Overall	42 (42.42%)	54 (54.55%)	3 (3.03%)	99 (100%)	38 (48.72%)	34 (43.59%)	6 (7.69%)	78 (100%)	177 (100%)

to dentists of Taiwan free of charge for the first time in October 2022.[8] The consideration was not only the pandemic factor, but also balancing the urban-rural gap in Taiwan's dental education resources. The theme of dental radiation technology was suitable for all types of dentists, and this online DCE course could attract dentists from any regions of Taiwan to participate. Our results showed the consistent good learning effectiveness between the participating dentists in October 2022 and those in March 2023 without significant difference. Therefore, we thought that it was reasonable to combine the two groups of participating dentists into a whole to analyze and interpret their performance together. In overall, among 324 dentists who registered the online DCE course, 253 dentists actually participated in the online course with an attendance rate of 78.09% (253/324). A possible explanation of the high absence rate (21.91%) of this online DCE course might be that this course was free of charge and the applicant did not need to pay any price if he or she refused to participate in this course finally. From another viewpoint, 253 dentists from all over Taiwan participated in this online DCE course, accounting for 1.57% (253/16,158.5) of the total number of practicing dentists at that time, that was still an impressive result of this course.

Among 93 dentists who answered the open question, the vast majority (80.65%, 75/93) expressed positive emotions towards this online course, indicating that most dentists readily accepted the online DCE courses. Furthermore, they hoped that this course would be continued and advanced courses such as the application of CBCT in dentistry would be conducted in the future, whereas among them, there was almost no negative influence due to availability and access to the online DCE courses.

We analyzed the composition of 249 participating dentists who completed the questionnaire. There were 170 (68.27%) males and 79 (31.73%) females. This gender ratio was very consistent with that of registered dentists in Taiwan in 2021, because there were 10,997 (69.35%) male dentists and 4860 (30.65%) female dentists in 2021.[9] Of these 249 participants, there were 127 (51.00%) dental specialists and 122 (49.00%) general dentists with 50 (20.08%) working in hospitals and 199 (79.92%) in dental clinics. According to the information on the website of the Ministry of Health and Welfare, by the end of 2022, the total number of dental specialist certificates in Taiwan was 5743. At present, there are more than 16,000 practicing dentists. Thus, it is roughly estimated that about 30% of the current practicing dentists have specialist qualifications. On the other hand, of 15,741 practicing dentists in 2021, there were 2174 (13.81%) working in hospitals and 13,567 (86.19%) in dental clinics.[10] Compared with the composition of all practicing dentists, the results of this study showed that among participating dentists, the proportion of hospital dentists was relatively high, and that of dental specialists was particularly high. This means that compared with clinic dentists and general dentists, hospital dentists and dental specialists may be more actively seeking dental course resources. Furthermore, among the current 10 dental specialties in Taiwan, all had their specialists to participate in this course. This just indicates that, in addition to general dentists, dental radiation technology is

Table 6 Numbers of dentists who participated in this course and practicing dentists in October 2022 and in March 2023 and their participation rates (%) by practice registration place.

Practice registration place	Region	October 2022			March 2023			Overall		
		Number of participating dentists	Number of practicing dentists	Participation rate (%)	Number of participating dentists	Number of practicing dentists	Participation rate (%)	Number of participating dentists	Number of practicing dentists[a]	Participation rate (%)
New Taipei City	Northern	8	2815	0.28	7	2820	0.25	15	2817.5	0.53
Taipei City	Northern	11	3551	0.31	7	3569	0.20	18	3560	0.51
Taoyuan City	Northern	2	1398	0.14	1	1400	0.07	3	1399	0.21
Taichung City	Central	8	2087	0.38	29	2110	1.37	37	2098.5	1.76
Tainan City	Southern	10	1198	0.83	4	1198	0.33	14	1198	1.17
Kaohsiung City	Southern	7	1976	0.35	9	1979	0.45	16	1977.5	0.81
Keelung City	Northern	9	203	4.43	10	211	4.74	19	207	9.18
Hsinchu City	Northern	18	387	4.65	2	390	0.51	20	388.5	5.15
Chiayi City	Southern	3	240	1.25	16	244	6.56	19	242	7.85
Hsinchu County	Northern	1	282	0.35	0	286	0	1	284	0.35
Miaoli County	Central	2	201	1.00	3	200	1.50	5	200.5	2.49
Changhua County	Central	0	609	0	2	618	0.32	2	613.5	0.33
Nantou County	Central	2	166	1.20	5	164	3.05	7	165	4.24
Yunlin County	Central	7	181	3.87	6	179	3.35	13	180	7.22
Chiayi County	Southern	5	101	4.95	1	99	1.01	6	100	6.00
Pingtung County	Southern	17	251	6.77	1	251	0.40	18	251	7.17
Yilan County	Eastern	4	192	2.08	7	195	3.59	11	193.5	5.68
Hualien County	Eastern	1	160	0.63	5	159	3.14	6	159.5	3.76
Taitung County	Eastern	16	69	23.19	1	67	1.49	17	68	25.00
Penghu County	Outlying islands	0	36	0	0	36	0	0	36	0
Kinmen County	Outlying islands	1	19	5.26	1	20	5.00	2	19.5	10.26
Overall		132	16,122	0.82	117	16,195	0.72	249	16,158.5	1.54

[a] This number referred to the average number of practicing dentists in October 2022 and in March 2023.

Table 7 Numbers of dentists who participated in this course and practicing dentists in October 2022 and in March 2023 and their participation rates (%) by administrative or geographical region.

Practice registration place	October 2022			March 2023			Overall		
	Number of participating dentists	Number of practicing dentists	Participation rate (%)	Number of participating dentists	Number of practicing dentists	Participation rate (%)	Number of participating dentists	Number of practicing dentists[a]	Participation rate (%)
Municipality									
Municipalities (n = 6)	46	13,025	0.35	57	13,076	0.44	103	13,050.5	0.79
Non-municipalities (n = 15)	86	3097	2.78	60	3119	1.92	146	3108	4.70
City/county									
Cities (n = 9)	76	13,855	0.55	85	13,921	0.61	161	13,888	1.16
Counties (n = 12)	56	2267	2.47	32	2274	1.41	88	2270.5	3.88
Region									
Northern region (n = 6)	49	8636	0.57	27	8676	0.31	76	8656	0.88
Central region (n = 5)	19	3244	0.59	45	3271	1.38	64	3257.5	1.96
Southern region (n = 5)	42	3766	1.12	31	3771	0.82	73	3768.5	1.94
Eastern region (n = 3)	21	421	4.99	13	421	3.09	34	421	8.08
Outlying islands (n = 2)	1	55	1.82	1	56	1.79	2	55.5	3.60
Overall	132	16,122	0.82	117	16,195	0.72	249	16,158.5	1.54

[a] This number referred to the average number of practicing dentists in October 2022 and in March 2023.

also a common professional knowledge and skill that is necessary for various dental specialists.

Our previous studies found that there is a serious urban-rural gap in dental resources in Taiwan. Dental schools, medical centers, training institutions, and dental academic groups are all concentrated in metropolitan areas, and these institutions are also the ones that mainly provide the DCE courses.[9–14] Therefore, there is also a serious urban-rural gap in dental education resources including the DCE courses. Remote dentists need to spend more cost and time to complete their DCE points in the urban areas, especially those from outlying islands, that may indirectly reduce their capacity to provide dental services to remote people. Therefore, if the DCE policy is based on the premise of fully implementing physical courses, it may have a negative impact on the rural dental services.

Since the number of practicing dentists in each city and county varies greatly, simply analyzing the number of dentists participating in this course in each city and county cannot truly reflect the differences of dentists participating in this online DCE course in each city and county. Therefore, we calculated the participating rate based on the ratio of the numbers of participating dentists to practicing dentists in each city and county. The results showed that there were dentists from almost all over Taiwan participating in this online DCE course, especially many dentists from remote areas, eastern region, and outlying islands. Moreover, surprisingly the participation rates in non-municipalities (4.70%), counties (3.88%), the eastern region (8.08%), and the outlying islands (3.60%) were much higher than those in municipalities (0.79%), cities (1.16%), and the western region including the northern region (0.88%), central region (1.96%), and southern region (1.94%). This finding indicates that dentists in remote areas are more actively seeking opportunities for participating continuing education through the online courses that transcend the constraints of geographic area. Because Taiwan has a serious problem of uneven distribution of dental resources and dental education resources, the implementation of the online DCE courses can make up for the gap caused by the uneven geographical distribution of dental education resources in Taiwan.

We conclude that the participating dentists express positive feedback on the online DCE courses, and the online DCE courses can reduce the urban-rural gap in dental education resources. We believe that all dental professional knowledge is suitable for the online courses to be provided to dentists all over Taiwan, especially those courses that do not involve clinical hands-on and belong to the common dental professional knowledge required by all dentists, such as dental radiology, oral health education knowledge, medical ethics, medical law, and other related fields. We also believe that after the COVID-19 pandemic, it is still necessary to implement the online DCE courses. Since the participants' convenience and a high level of institutional support can enhance the integration of the online proportion in dental education resources.[15] Various institutions that provide dental professional courses shall still try to implement the online courses in various ways to reduce the urban-rural gap in dental education resources. In fact, the online course is an important tool to bridge the gap in educational resources between urban and rural areas, that

is more important than the original consideration that the online courses are designed for students in the COVID-19 pandemic. Therefore, the use of the online DCE courses in dental education will be a future trend.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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