RESEARCH AND EDUCATION

Learner behaviors in synchronous online prosthodontic education during the 2020 COVID-19 pandemic

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Since early 2020, coronavirus disease 2019 (COVID-19) has become a worldwide pandemic crisis.[1] Countries and regions have established pandemic prevention policies, which have had major impacts on social, economic, medical and dental activities, as well as lifestyles. Countries have adopted social distancing policies with varying degrees of success. People are increasingly realizing that even after the pandemic dissipates, social distancing may continue long into the future.

Important changes have also occurred in the provision and utilization of dental care and education,[2-4] with the emergence of COVID-19 disrupting, in particular, how medical education, including dental education, is structured and provided.[4-8] The COVID-19 pandemic highlighted the need for alternative educational methods such as distance learning.[4-8] In traditional dental education, high-quality practical skills

ABSTRACT

Statement of problem. Synchronous online prosthodontic courses became a popular learning mode during the 2020 COVID-19 pandemic crisis. Nonetheless, the extent of learner participation and completion of these courses remains unknown.

Purpose. The purpose of this study was to assess learner behaviors in synchronous online prosthodontic continuing education lectures in China during the 2020 COVID-19 pandemic.

Material and methods. All live online prosthodontic courses held by an online dental school in China from February to May 2020 were retrieved. The no-cost lectures could be accessed anonymously and viewed repeatedly on the day of broadcast. Learning behavior data (teacher speaking time, audience total, timing of first visit to the online classroom, viewing time, and completion rate) were obtained. Learning progress was calculated by dividing viewing time by teacher speaking time. When a learner progressed through 95% of a lecture, the lecture was considered completed.

Results. A total of 41 781 learners participated in 18 online prosthodontic courses, which had a mean duration of 77.2 ±15.8 minutes. For each lecture, 2321 ±1454 participants attended, with 510 ±404 participants completing each session. There were 13 098 participants (31.35%) who viewed the lectures for less than 1 minute. Approximately half of the participants viewed the lectures for less than 10 minutes, with their learning progress failing to pass 10%. The average completion rate was 21.97%, with variation in completion rate dependent on when a learner first visited the online classroom. Significant differences were found among the lecture completion rates and the timing of the first visit to the online classroom ($P<.001$).

Conclusions. Synchronous online prosthodontic education courses in China had a high number of participants but low learning progress and completion rates during the 2020 COVID-19 pandemic. (J Prosthet Dent 2021;126:653-7)

training is inseparable from iterative, face-to-face guidance and communication.[9] Today, dental education methods are increasingly diverse, with distance learning becoming an important supplement to on-site

Clinical Implications

During the COVID-19 pandemic crisis, synchronous online prosthodontic education became a popular learning mode and was highly engaged. Nonetheless, the students' learning progress and completion rate remained low. When conducting synchronous online courses, course content and teaching skills must be optimized, and learners guided to visit the online classroom for the first time within 1 hour of the start of the course to improve the completion rate.

Table 1. Summary of 18 synchronous online prosthodontic lectures

Theme	Value
Total lectures (*n*)	18
Total participants (*n*)	41 781
Average instruction duration (min, mean ±SD)	77.17 ±15.83
Average audiences (*n*, mean ±SD)	2321 ±1453
Average audiences of completed (*n*, mean ±SD)	510 ±404
Average viewing time (min, median [interquartile range])	11.25 [0.52, 64.60]
Average learning progress (%, median [interquartile range])	14.83 [0.67, 87.14]

SD, standard deviation.

education.[10,11] Distance education may prove to be an effective alternative to traditional education methods, and students have been enthusiastic about online learning.[12-15] Synchronous online learning occurs via a live, virtual interactive classroom. In response to the COVID-19 crisis, dental educators have converted university courses to an online format to avoid the risk of COVID-19 transmission during in-person education.[4,16] Using modern technology, students can access lectures at home, thereby avoiding on-site attendance and reducing the risk of infection.

Since the onset of COVID-19, most face-to-face academic meetings have been suspended or canceled.[17,18] Synchronous online dental education courses and their participants have increased significantly, in part because of the courses' ability to overcome the geographical constraints typically found in traditional modes of education.[5,19] However, synchronous online courses are not as regulated as on-site classes.[20-22] Often, instructors cannot supervise learners with respect to their attendance and participation. Furthermore, the current era of information overload can create a multitude of distractions and obstacles for learners when joining and completing an online course. Importantly, the extent of learner participation and completion of these courses remains unknown, and the authors are unaware of research that has investigated the effectiveness of synchronous online learning during the 2020 COVID-19 pandemic.

The present observational study assessed learner behaviors in synchronous online prosthodontic continuing education lectures in China during the 2020 COVID-19 pandemic. The primary purpose was to evaluate the participation, learning progress, and completion rate of the courses. A secondary purpose was to determine whether the completion rate was affected by the participant's first visit (FV) time to the online classroom. This study aimed to illustrate the reality of synchronous online learning and provide a reference for improving the effectiveness of distance prosthodontic education. The

null hypotheses were that the completion rate of synchronous online prosthodontic education during the 2020 COVID-19 pandemic would not be influenced by the specific lectures and the learners' first-visit time to the online classroom.

MATERIAL AND METHODS

This research was conducted by using lectures from a well-known dental online education institution, Tsmile, based in PR China. All live online prosthodontic lectures held from February to May 2020 were retrieved. These lectures covered contemporary clinical topics in fixed prosthodontics, implant dentistry, and esthetic dentistry. Each lecture consisted of 60 to 90 minutes of instruction, with some exceeding 90 minutes because of interactive discussion. The no-cost lectures could be accessed anonymously from smartphones or laptop or tablet computers. Each lecture could be viewed repeatedly on the day of broadcast.

Learning behavior data (teacher speaking time, audience total, timing of FV to the online classroom, viewing time, and completion rates) were obtained from the online platform. No demographic information was collected, so ethical approval was not required. Only participants with data points for each variable were included for analysis. Learning progress was calculated by dividing viewing time by teacher speaking time. When a learner progressed through 95% of a lecture, the lecture was considered completed.

The online classrooms allowed early access to the course introduction before the course officially started, giving learners to FV the online classroom anywhere between several hours to several days before the start of the course. The participants were divided into 3 groups as per the timing of their FV to the online classroom: early group (FV≥60 minutes before the lecture began); punctual group (FV<60 minutes before the lecture began); and late group (FV occurred after the lecture had started). Differences in completion rates among lectures were analyzed, as well as differences among FV times.

Normally distributed continuous variables were presented as mean ±standard deviation. Non-normal continuous variables were presented as median (interquartile range). Count variables were presented as n (%).
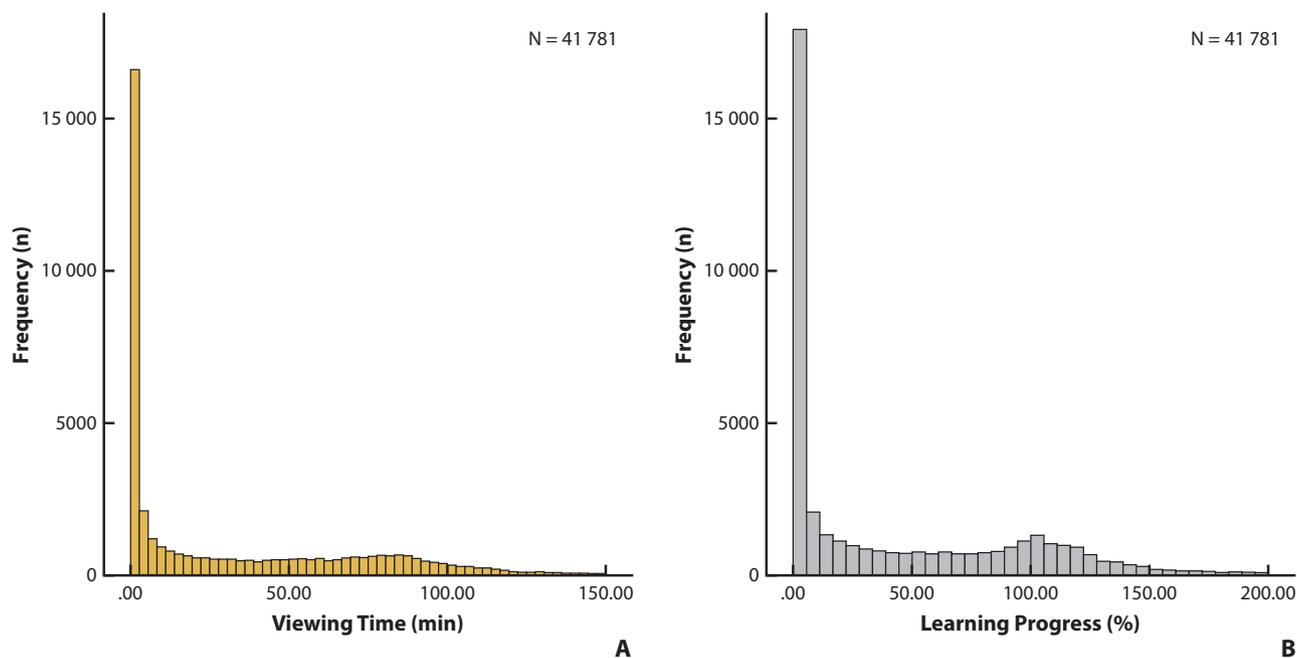
Figure 1. Viewing time and learning progress of participants in synchronous online prosthodontic lectures (N=41 781) A, Viewing time. B, Learning progress.

The chi-square test for significant differences between lectures and FV time was used with a statistical software program (IBM SPSS Statistics, v22.0; IBM Corp) (α=.05).

RESULTS

Overall, 41 781 learners participated in 18 online prosthodontic lectures, which had a mean instruction duration of 77.17 ±15.83 minutes (Table 1). For each lecture, 2321 ±1454 participants attended, with 510 ±404 participants completing each session. The viewing time and learning progress followed skewed distributions (Fig. 1). A total of 13 098 participants (31.35%) viewed the lectures for less than 1 minute (Fig. 1A). Approximately half of the participants viewed the lectures for less than 10 minutes (Fig. 1A), with their learning progress failing to pass 10% (Fig. 1B). Some participants viewed parts or all of the lecture repeatedly; 19.51% of participants had learning progress values that exceeded 100% (Fig. 1B). The completion rate ranged from 9.27% to 31.85%, with an average completion rate of 21.97% (Table 2). There were significant differences among the completion rates of the lectures (P<.001) (Table 3).

Learners who visited the online classroom for the first time less than 60 minutes before the lecture began (punctual group) had the highest completion rate of 50.75% (Table 4). In contrast, the learners whose FV occurred more than 60 minutes before the lecture began (early group) had the lowest completion rate (14.00%). The completion rate of those first visiting the online

classroom after the lecture started (late group) was 19.09%. There were significant differences among the completion rates of each FV group (P<.001) (Table 5).

DISCUSSION

This research assessed learner behaviors in synchronous online prosthodontic education courses in China during the 2020 COVID-19 pandemic. The participation, learning progress, and completion rates of learners and the data's relationship to the lectures and to the timing of learners' first visits to the online classroom were evaluated. The results indicated that synchronous online prosthodontic education courses were highly engaged with low learning progress. The overall completion rate was low and was affected by lectures and the FV time to the online classroom. Therefore, the null hypotheses were rejected.

Synchronous online courses became a popular learning mode with a high number of participants in China during the 2020 COVID-19 pandemic. Different factors contributed to its recent popularity. Time is an important factor restricting dentist participation in continuing education.[23] During the pandemic, dental clinical work was greatly reduced,[3] providing dentists with more free time for continuing education.[5] In addition, synchronous courses are easily accessed, free from space constraints, and do not require face-to-face contact, helping to reduce the transmission risk of COVID-19. These attributes may contribute to a high number

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Table 2. Learner completion rates of synchronous online prosthodontic lectures (*N*=41 781)

Lecture No.	Participants (*n*)	Completion Rate (*n* (%))*	
		Yes	No
1	5766	931 (16.15)[a]	4835 (83.85)[a]
2	738	124 (16.80)[a,b,c]	614 (83.20)[a,b,c]
3	2696	350 (12.98)[c,d,e,f,g]	2346 (87.02)[c,d,e,f,g]
4	1475	253 (17.15)[a]	1222 (82.85)[a]
5	1207	179 (14.83)[a,c,f,g]	1028 (85.17)[a,c,f,g]
6	2454	433 (17.64)[a]	2021 (82.36)[a]
7	2477	767 (30.96)[h,i]	1710 (69.04)[h,i]
8	881	92 (10.44)[d,e,f,g]	789 (89.56)[d,e,f,g]
9	1097	102 (9.30)[e]	995 (90.70)[e]
10	723	67 (9.27)[e,g]	656 (90.73)[e,g]
11	868	141 (16.24)[a,c,d,f]	727 (83.76)[a,c,d,f]
12	1573	363 (23.08)[b,j]	1210 (76.92)[b,j]
13	3934	953 (24.22)[j]	2981 (75.78)[j]
14	3863	1040 (26.92)[i,j]	2823 (73.08)[i,j]
15	4653	1482 (31.85)[h]	3171 (68.15)[h]
16	2467	716 (29.02)[h,i]	1751 (70.98)[h,i]
17	2196	533 (24.27)[j]	1663 (75.73)[j]
18	2713	653 (24.07)[j]	2060 (75.93)[j]
Total	41 781	9179 (21.97)	32 602 (78.03)

Values with same superscript letters indicate completion rate with no statistically significant difference between those lectures (*P*>.05). *Learning progress that reached 95% of given lecture resulted in lecture being categorized as completed.

Table 3. Results of chi-square test comparing completion rate by synchronous online prosthodontic lectures

	Value	df	*P*
Pearson chi-square	1126.234*	17	<.001
Likelihood ratio	1166.541	17	<.001
Linear-by-linear association	523.016	1	<.001
N of valid cases	41 781	—	—

*0 cells (0.0%) expected count less than 5. Minimum expected count 158.84.

Table 4. Correlation of completion rate and first-visit time to online classroom

First Visit Time	Participants (*n*)	Completion of Lecture*	
		Yes	No
More than 60 min before the lecture	11 306	1583 (14.00)[a]	9723 (86.00)[a]
Less than 60 min before the lecture	5620	2852 (50.75)[b]	2768 (49.25)[b]
After the lecture started	24 855	4744 (19.09)[c]	20 111 (80.91)[c]
Total	41 781	9179 (21.97)	32 602 (78.03)

Values with same superscript letters indicate completion rate with no statistically significant difference between those first visit time (*P*>.05). *Learning progress that reached 95% of given lecture resulted in lecture being categorized as completed.

Table 5. Results of chi-square test comparing completion rate by first visit time to online classroom

	Value	df	*P*
Pearson chi-square	3254.227*	2	<.001
Likelihood ratio	2817.157	2	<.001
Linear-by-linear association	6.242	1	.012
N of valid cases	41 781	—	—

*0 cells (0.0%) expected count less than 5. Minimum expected count 1234.68.

of participants in such courses, participation that is rarely matched by in-person classes.

Nevertheless, more attention must be paid to learner levels of engagement.[5,19] Participant behavior in synchronous online courses has not been regulated.[20] As a result, one third of the participants viewed lectures for less than 1 minute, and nearly half of the participants progressed through less than 10% of the lecture content. Only one fifth completed the online class. This may be because the focus of responsibility for the class has shifted, to some extent, from the teacher to the students.[21] Learners can enter and leave the online classroom freely and may get distracted by their surroundings, particularly as they participate in courses outside a formal classroom.[22] Distance learners may find it difficult to motivate themselves to stay engaged for long periods. In addition, deficient hardware or software infrastructure, inadequate technological abilities, and a complex learning environment are also difficulties that students may face in distance education.[21,22] Nonetheless, to increase the effectiveness of online education, learning progress and completion rates need first to be increased.

The learner total and completion rate was significantly related to specific lectures, perhaps because of varying interest in the lecture topics, content, and speakers. Therefore, the course design needs to consider the interest of learners to increase attentiveness throughout each class. For online classes, it may be more difficult to engage in timely and effective interaction with students, which is a key component of generating interest in online education.[21] The development of online courses requires effort from both experts and learners. When developing online lectures, attention should be paid to teaching methods and teacher abilities, experience, and presentation skills.[10] The course must contain effective visual learning elements, as well as easy-to-express and easy-to-understand content.[10] To achieve this goal, it is necessary to provide systematic training for teachers.[22]

Learner completion rates were also related to the timing of their FV to the online classroom. Audience members who visited the online classroom for the first time within 60 minutes before the course began had the highest completion rate of 50.75%, exceeding the average completion rate of 21.97%. Some learners entered the online classroom more than 60 minutes before the start of the course, visiting the classroom a few hours or days previously – they may be distracted by their surrounding environment, which leads to a decline in completion rate. For learners who entered the online classroom for the first time less than 60 minutes before the lecture began, they were less likely to be disturbed by their surroundings, which is conducive to completing the course. Some

learners entered the live online classroom after the lecture started. Being late suggests they may not have paid enough attention to the course and could not fully comprehend the course content when entering midway through. This may explain why the completion rate was low for the late group.

Given the "new normal" ushered in by the pandemic, dental educators are being forced to develop innovative strategies to continue educational tasks during the crisis.[8] Dentists are willing to conduct synchronous online dental continuing education courses, indicating that this educational model may be broadly adopted in the future.[15] It is possible to continue to teach theoretical content online. However, face-to-face classrooms are significantly more conducive to student-teacher and student-student interactions.[20] When discussing clinical treatments, an Internet-based discussion is a less effective educational method compared with in-person discussions, which involve more natural ways of communicating.[11] Therefore, when conducting synchronous online courses, the focus should be on theoretical explanations, not clinical treatment discussions.

Limitations of this study included that the synchronous online prosthodontic education institutions and courses evaluated were limited in scope. There may be differences between institutions and their courses, and the course quality and teaching effectiveness were not evaluated. Participation and completion rates only reflect the act of viewing course content online and do not necessarily reflect effective learning. In addition, the data were derived during a unique historical period; thus, the results cannot be generalized excessively. Additional studies about the effect of synchronous online education courses on learner theoretical knowledge and practical skills, in China and worldwide, are necessary.

CONCLUSIONS

Based on the findings of this survey study, the following conclusions were drawn:

1. Synchronous online prosthodontic courses had a high number of participants but low learning progress and completion rates.
2. The completion rates were significantly related to individual lectures and the timing of the learners' FV to the online classroom.
3. The impact of the 2020 COVID-19 pandemic may be far-reaching, including in the realm of dental education, and may forever change the way dentists are taught.

REFERENCES

1. World Health Organization. Coronavirus disease (COVID-2019) situation reports. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/. Accessed July 17, 2020.
2. Guo H, Zhou Y, Liu X, Tan J. The impact of the COVID-19 epidemic on the utilization of emergency dental services. J Dent Sci 2020;15:564-7.
3. Yang Y, Zhou Y, Liu X, Tan J. Health services provision of 48 public tertiary dental hospitals during the COVID-19 epidemic in China. Clin Oral Investig 2020;24:1861-4.
4. Meng L, Hua F, Bian Z. Coronavirus disease 2019 (COVID-19): emerging and future challenges for dental and oral medicine. J Dent Res 2020;99:481-7.
5. Liu X, Zhou J, Chen L, Yang Y, Tan J. Impact of COVID-19 epidemic on live online dental continuing education. Eur J Dent Educ 2020;24:786-9.
6. Rose S. Medical student education in the time of COVID-19. JAMA 2020;323:2131-2.
7. Theoret C, Ming X. Our education, our concerns: medical student education impact due to COVID-19. Med Educ 2020;54:591-2.
8. Elangovan S, Mahrous A, Marchini L. Disruptions during a pandemic: gaps identified and lessons learned. J Dent Educ 2020;84:1270-4.
9. Liu X, Liu M, Yang Y, Fan C, Tan J. Step-by-step teaching method improves the learner achievement in dental skill training. Eur J Dent Educ 2019;23:344-8.
10. Kavadella A, Kossioni A, Tsiklakis K, Cowpe J, Bullock A, Barnes E, et al. Recommendations for the development of e-modules for the continuing professional development of European dentists. Eur J Dent Educ 2013;17:45-54.
11. Martin N, Lazalde OM, Stokes C, Romano D. An evaluation of remote communication versus face-to-face in clinical dental education. Br Dent J 2012;212:277-82.
12. Santos GNM, Leite AF, Figueiredo PTdS, Pimentel NM, Flores-Mir C, de Melo NS, et al. Effectiveness of e-learning in oral radiology education: a systematic review. J Dent Educ 2016;80:1126-39.
13. Cruz AD, Costa JJ, Almeida SM. Distance learning in dental radiology: immediate impact of the implementation. Braz Dent Sci 2014;17:90-7.
14. Olmsted JL. Direct assessment as a measure of institutional effectiveness in a dental hygiene distance education program. J Dent Educ 2014;78:1460-7.
15. Iqbal S, Shafiq A, Iqbal N. Perceptions of undergraduate dental students towards e-Learning in Lahore medical and dental college. Pak J Med Health Sci 2016;10:1191-3.
16. Iyer P, Aziz K, Ojcius DM. Impact of COVID-19 on dental education in the United States. J Dent Educ 2020;84:718-22.
17. Barabari P, Moharamzadeh K. Novel coronavirus (COVID-19) and dentistry–a comprehensive review of literature. Dent J 2020;8:53.
18. Machado RA, Bonan PRF, Perez DEdC, Martelli Junior H. COVID-19 pandemic and the impact on dental education: discussing current and future perspectives. Braz Oral Res 2020;34:e083.
19. Barnes E, Bullock AD, Bailey S, Cowpe J, Karaharju-Suvanto T. A review of continuing professional development for dentists in Europe. Eur J Dent Educ 2013;17:5-17.
20. Kunin M, Julliard KN, Rodriguez TE. Comparing face-to-face, synchronous, and asynchronous learning: postgraduate dental resident preferences. J Dent Educ 2014;78:856-66.
21. Rashid M, Elahi U. Use of educational technology in promoting distance education. Turk Online J Distance Educ 2012;13:79-86.
22. Zhang W, Wang Y, Yang L, Wang C. Suspending classes without stopping learning: China's education emergency management policy in the COVID-19 outbreak. J Risk Financial Manag 2020;13:55.
23. Nazir M, Al-Ansari A, Alabdulaziz M, AlNasrallah Y, Alzain M. Reasons for and barriers to attending continuing education activities and priorities for different dental specialties. Open Access Maced J Med Sci 2018;6:1716-21.

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