ORIGINAL ARTICLE

A cross-sectional study comparing live and recorded videos for undergraduate teaching of orthodontic appliance construction during the COVID-19 pandemic

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ABSTRACT

Introduction: To compare students' perceptions of the effectiveness of recorded video demonstrations (RVD), introduced during the COVID-19 pandemic, versus traditional face-to-face demonstrations (FTFD) in the teaching and learning of orthodontic upper removal appliance (URA) construction and to compare between their chosen learning method and self-reported competencies across various stages of URA construction. Learning preferences and the perceived technical quality of the recorded videos were also assessed. **Materials and Methods:** A total of 97 fourth-year dental students participated in the study, divided into two groups. The first group learnt URA construction via RVD and the other group via FTFD. Both groups completed two URAs, which were assessed by orthodontists and given a score. After the assessment, students from the FTFD group were given the RVD to watch. Both groups answered an online validated questionnaire regarding their perceptions on their learning experience. **Results:** Students from the FTFD group rated RVD significantly higher in terms of information consistency (4.13 ± 0.84) and learning convenience (4.33 ± 0.77) whereas FTFD was rated higher for better understanding (4.16 ± 0.69), $p<0.05$. Both groups perceived the RVD effective in gaining knowledge, technical skills as well as providing learning convenience. **Conclusions:** Both RVD and FTFD were equally effective and relevant in the teaching and learning of URA construction. Learning is by individual preference; hence hybrid learning may be the best way to enhance dental students' knowledge and competency in URA construction.

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INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) described as coronavirus disease 2019 (COVID-19) was declared a pandemic in 2020 (1). To curb the high rate of infection and contain the disease, the Malaysian government declared a mandatory lockdown, the Movement Control Order (MCO), which restricted movement in and out of areas as well as mandatory physical distancing, including the closure of educational institutions (2, 3). Consequently, dental universities were strongly affected by the pandemic as physical classes and live demonstrations were put on a halt. As a result, students faced significant challenges in completing their course requirements which would lead to delays in graduation. Therefore, to curb this problem, universities had to implement "distance learning" tools to continue dental education amid the pandemic. This poses a great challenge as practical clinical skills which were traditionally taught via live demonstrations to small groups of students had to be carried out online. The universities had to ensure that the quality of dental education provided during the pandemic was up to par with the standards set by the Malaysian Dental Council, to produce competent graduates. Since these skills are of critical importance in dentistry, it is vital that universities were able to effectively deliver courses which heavily rely on live teaching and lecturer-student interaction through a platform compatible with the COVID-19 restrictions.

The orthodontic upper removable appliance (URA) construction course is an important and fundamental component of orthodontic teaching of undergraduate dental students. A scoping review on undergraduate orthodontic curricula reported that removable appliance construction was the most commonly included component among European dental schools and a key learning outcome in a dental college in Pakistan (4). Traditionally, the teaching of this course involved live face-to-face demonstrations to groups of students. However, due to COVID-19 physical distancing regulations and closure of the faculty, this method of teaching and learning could not be carried out, similarly to multiple dental universities around the globe (5–8). This resulted in students being unable to complete their URA construction while deadlines for submission were approaching. Students had to complete this course before starting clinical sessions. To continue teaching the course throughout the pandemic, the faculty produced a series of videos in lieu of the face-to-face demonstrations. The procedures were performed by the same qualified technical instructors who gave the live demonstrations, recorded, and uploaded on the YouTube platform. The faculty leveraged the online learning portal of the university to disseminate the videos. It offered a suitable platform where students had easy access to the video links and other relevant course materials. In addition, students were able to ask questions, give comments and carry out discussions on the platform with input from qualified lecturers, enabling them to learn from each other in a social learning network (9–11). This aimed to replicate live demonstrations where interactive opportunities enhanced the learning experience in dental education. (12).

Originally, live demonstration was the preferred method of teaching as it was able to provide a deeper understanding and increase students' confidence in the skills involved (13). Nevertheless, video demonstration allows better visualization, overcomes the shortage of manpower and enhances self-learning as it can be watched as many times as the student wishes (14, 15). Studies have shown that recorded videos were just as effective as live demonstrations in orthodontic wire bending training (14, 16). Another study found that both methods resulted in a similar level of understanding of the procedure, but students still preferred live demonstrations over recorded videos (15).

However, most of the previous research was directed toward comparing the efficiency of video versus live demonstrations in constructing a singular component of the URA, primarily the Adam's clasp (14, 17). It is imperative to acknowledge that the URA comprises several other integral components, including but not limited to the Southend clasp, Z-spring, finger spring, and base plates. Each of these components may necessitate distinct levels of technical proficiency and present varying levels of complexity due to the involvement of wire bending techniques that encompass a wide array of forms, such as U-loop configurations, coils, in addition to the requisite skills for boxing, waxing, trimming, and the polishing of the base plates. Therefore, it holds merit to explore the performance of students in constructing the URA as a whole.

To the best of the authors' knowledge, no studies have been carried out that investigate the effectiveness of recorded video demonstrations in the teaching and learning of URA construction. To fill this gap, this study aims to compare the students' perception of effectiveness between recorded video and face-to-face demonstrations in teaching and learning of orthodontic URA construction. Furthermore, the present study also compares the students' learning method with their self-reported competencies in the various stages of URA construction, as well as their preference of learning method along with the technical quality of the recorded videos.

MATERIALS AND METHODS

Participants

This study was conducted from October 2020 to October 2022 and involved two cohorts of fourth-year dental undergraduate students from the 2020/2021 and 2021/2022 academic sessions. Ethical approval was obtained from the Research and Ethics Committee of the Faculty of Dentistry, Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2022-530). Informed consent for research and publication was obtained from all participants. Participants were assigned to two groups based on their academic session: the recorded video demonstration (RVD) group and the face-to-face demonstration (FTFD) group. All students were required to construct 2 URAs. The URA is a removable orthodontic appliance consisting of multiple stainless-steel wire components united by an acrylic base, which is unique to each cast. The wire components of the first URA were Adam's clasps, labial bow, and finger spring. The second URA consisted of Adam's clasps, a Southend clasp, and a Z-spring. Students in the RVD group were given eight instructional videos via YouTube links to construct both the URAs. The videos included close-up shots of the demonstrator's hands, along with the casts, wires and instruments that were used, accompanied by voice-over instructions. The instructional videos were custom made and recorded in full HD (1080p) quality. The videos contained necessary information to enable the students to carry out the URA construction and check each stage for accuracy. For the FTFD group, the demonstrations were given in the laboratory by trained orthodontic technicians with standardized instructions. The students had to complete both URAs within three months. Both URAs were later assessed by two orthodontists. A standardized rubric was used to assess the wire bending and the baseplate. It includes producing the correct shape and position of each active and retentive component. In addition, the finger spring and z-spring must have the correct waxing and boxing, movable and free from surrounding gingiva. The ideal base plate must be smooth, shiny, not porous and fits well on the model. Each URA carries 30 marks, hence 2 URAs produced a total score of 60 marks. Prior to the assessment, both intra- and inter-examiner reliability were evaluated using the intraclass correlation coefficient (ICC) on ten URAs, assessed two weeks apart. The results demonstrated good reliability, with ICC values of 0.854 for intra-examiner and 0.832 for inter-examiner assessments (18).

After the assessment, students from the FTFD group were instructed to watch the same videos that were given to the RVD group. Then, all students were required to answer a questionnaire regarding their perceptions on their orthodontic wire bending learning experience.

Questionnaire

A four-part questionnaire was developed by a panel of orthodontic specialists with more than ten years of experience. Face validity and content validity were carried out prior to actual data collection. The first part was used to gain demographic information about each respondent. The purpose of the second part was to gain information regarding their level of agreement on a scale of 1 to 5 (with 1 being strongly disagreed and 5 being strongly agreed) in their perceived effectiveness of the RVD in terms of knowledge, technical skills, and learning convenience. Students were also instructed to rate their self-perceived confidence in performing various aspects of URA construction using the same scale. A third part of the questionnaire was related to students' preference for either the recorded video demonstrations (RVD), face-to-face demonstrations (FTFD), or a combination of both in various aspects of learning. In the last part of this questionnaire, students were asked to rate the technical aspects of the videos. Since the FTFD group had experienced both methods of learning, they were specifically asked to compare the effectiveness of RVD with FTFD in terms of knowledge, technical skills, and learning convenience.

Statistical analysis

The data were reported descriptively with tables as means of the scores. A normality test was done, and the data was found to be normally distributed. Therefore, t-tests were done to compare both groups' perception towards the learning methods and scores from the assessment. All statistical tests were conducted using IBM SPSS© version 26.

RESULTS

Demographic data

A total of 97 students participated in the study, with 42 students assigned to the RVD group and the remaining 55 to the FTFD group. 27.8% of participants were male and 72.2% were female, with a mean age of 24.61 ± 0.73. There were 49 (50.5%) Malays, 28 (28.9%) Chinese, 18 (18.6%) Indian students and two (2.1%) students from minority ethnic groups.

Comparing learning methods

Table I shows the comparison between RVD and FTFD among students from the FTFD group. They perceived RVD to be significantly more consistent in information taught (4.13 ± 0.84) as well as effective for learning at the student's own pace (4.31±0.77) and time (4.33 ± 0.77) compared to FTFD ($p<0.05$). However, FTFD was significantly more effective in increasing students' understanding (4.16 ± 0.69) ($p<0.05$). Nevertheless, there were no significant differences between RVD and FTFD in remembering, learning, and applying knowledge as well as technical skills.

Table I : Comparison between RVD and FTFD among students from the FTFD group

Items	Mean ± SD		p-value
	RVD	FTFD	
Knowledge			
I understand better	3.85 ± 0.78	4.16 ± 0.69	0.037*
I remember better	3.89 ± 0.83	4.04 ± 0.84	0.409
I learn better	3.95 ±0.83	3.98 ± 0.82	0.839
I can effectively apply the knowledge	3.87 ± 0.84	4.11 ± 0.71	0.118
The information taught is more consistent	4.13 ± 0.84	3.36 ± 0.97	<0.01*
Technical skills			
I am more productive in constructing the removable appliances	3.82 ± 0.86	4.07 ± 0.77	0.132
I can complete the wire bending quicker	3.84 ± 0.94	3.87 ± 0.82	0.852
I can complete the construction of removable appliance quicker	3.82 ± 0.88	3.82 ± 0.91	1
Learning convenience			
I can learn at my own pace	4.31 ± 0.77	3.05 ± 1.16	<0.01*
I can learn at my own time	4.33 ± 0.77	3.04 ± 1.14	<0.01*

RVD; recorded video demonstrations, FTFD; face-to-face demonstrations.
*Paired samples t-test shows statistically significant; $p<0.05$.

The general preference of learning methods of students from the FTFD group in the context of knowledge, technical skills and learning convenience were

Table II : Perceived preference of learning method among students from the FTFD group

Items	Frequency (Percentage, %)		
	RVD	FTFD	Both
Knowledge			
I understand better through	17 (30.9)	34 (61.8)	4 (7.3)
I remember better through	21 (38.2)	28 (50.9)	6 (10.9)
I learn better through	19 (34.5)	29 (52.7)	7 (12.7)
I can effectively apply the knowledge	16 (29.1)	34 (61.8)	5 (9.1)
The information taught is more consistent through	34 (61.8)	18 (32.7)	3 (5.5)
Technical skills			
I am more productive in constructing removable appliances through	20 (36.4)	28 (50.9)	7 (12.7)
I can complete the wire bending quicker through	23 (41.8)	24 (43.6)	8 (14.5)
I can complete the construction of removable appliance quicker through	21 (38.2)	27 (49.1)	7 (12.7)
Learning convenience			
I can learn at my own pace	40 (72.7)	14 (25.5)	1 (1.8)
I can learn at my own time	41 (74.5)	14 (25.5)	0 (0.0)

RVD; recorded video demonstrations, FTFD; face-to-face demonstrations, Both; combination of both RVD and FTFD.

illustrated in Table II. Students preferred FTFD for better understanding, remembering, learning, and applying knowledge. However, they preferred RVD (61.8%) for better information consistency. For learning convenience, the majority of students preferred RVD for learning at their own pace (72.7%) and time (74.5%).

Table III compares RVD and FTFD groups in their perceived ability to perform various parts of URA construction. Students from the FTFD group perceived that they were significantly more competent in bending the Adams clasp (4.20 ± 0.76), labial bow (4.23 ± 0.67), Southend clasp (4.27 ± 0.62), finger spring (4.29 ± 0.60) and Z-spring (4.25 ± 0.65) compared to the RVD group ($p < 0.05$). No significant differences were noted between the groups in the other aspects of URA construction. Regardless of the teaching method, both groups found that the most difficult part of URA construction was bending the Adam's clasp whereas the easiest was trimming and polishing the baseplate.

Table IV shows that the URA fabricated by students from the RVD group scored significantly higher total marks (43.29 ± 2.66) during the assessment by orthodontists compared to the FTFD group (40.54 ± 7.02), $p < 0.05$.

Table V compares the perception of both groups of students towards the RVD in terms of effectiveness in gaining knowledge and technical skills as well as providing learning convenience. Both groups of students perceived that the RVD was effective in gaining knowledge, technical skills and providing learning convenience. However, there were no significant differences in the effectiveness of RVD between students in both groups ($p < 0.05$). Learning convenience of the RVD was rated the highest for both groups of students.

Generally, students perceived the quality of the video to be good as the majority of the technical aspects of the

Table III : Perception on ability in performing URA construction

Item	Mean ± SD		p-value
	RVD group	FTFD group	
I am able to bend Adam's clasp	3.71 ± 0.97	4.20 ± 0.76	0.007*
I am able to bend labial bow	3.81 ± 0.89	4.23 ± 0.67	0.008*
I am able to bend Southend clasp	3.93 ± 0.81	4.27 ± 0.62	0.020*
I am able to bend finger spring	3.83 ±0.82	4.29 ± 0.60	0.002*
I am able to bend Z-spring	3.79 ± 0.95	4.25 ± 0.65	0.005*
I am able to perform waxing and boxing	4.05 ±0.83	4.33 ± 0.67	0.068
I am able to construct baseplate	4.17 ± 0.70	4.35 ± 0.70	0.214
I am able to trim and polish baseplate	4.19 ± 0.71	4.42 ± 0.57	0.082

RVD group; students from the recorded video demonstrations group, FTFD group; students from the face-to-face demonstration group.
* Independent samples t-test shows statistically significant; p<0.05.

Table IV : Competency of constructing upper removable appliance (URA)

Item	Mean ± SD		p-value
	RVD group	FTFD group	
URA total score	43.29 ± 2.66	40.54 ± 7.02	0.01*

RVD group; students from the recorded video demonstrations group, FTFD group; students from the face-to-face demonstration group.
* Independent samples t-test shows statistically significant; p<0.05.

Table V : Perception towards RVD in terms of knowledge, technical skills and learning convenience

Items	Mean ± SD		p-value
	RVD group	FTFD group	
Knowledge			
I understand better	3.67 ± 1.00	3.85 ± 0.78	0.302
I remember better	3.79 ± 1.05	3.89 ± 0.83	0.583
I learn better	3.76 ± 1.03	3.95 ± 0.83	0.333
I can effectively apply the knowledge	3.79 ± 1.05	3.87 ± 0.84	0.651
The information taught is more consistent	3.83 ± 1.03	4.13 ± 0.84	0.126
Technical skills			
I am more productive in constructing the removable appliances	3.76 ± 0.98	3.82 ± 0.86	0.765
I can complete the wire bending quicker through	3.69 ± 1.00	3.84 ± 0.94	0.463
I can complete the construction of removable appliance quicker	3.64 ± 0.91	3.82 ± 0.88	0.341
Learning convenience			
I can learn at my own pace	4.07 ± 1.05	4.31 ± 0.77	0.199
I can learn at my own time	4.07 ± 1.05	4.33 ± 0.77	0.168

RVD group; students from the recorded video demonstrations group, FTFD group; students from the face-to-face demonstration group.
Independent samples t-test.

video were rated high with mean scores of more than 4.00 (Table VI). Students were most satisfied with the ease of access to the video (4.19 ± 0.73) followed by the video design (4.14 ± 0.72). Students were least satisfied with the audio (3.99 ± 0.76) and visual (3.90 ± 0.81) aspects of the video.

Table VI : Perception on the technical quality of the online videos

Items	Mean score ± SD
Clear organization of information	4.04 ± 0.66
Pleasant video interface	4.04 ± 0.72
Easy to follow along	4.12 ± 0.67
Clear audio	3.99 ± 0.76
Clear visuals	3.90 ± 0.81
Reasonable duration	4.09 ± 0.71
Acceptable pace and speed	4.04 ± 0.72
Easy to access	4.19 ± 0.73
Recommended to another person	4.13 ± 0.76
Satisfaction of video design	4.14 ± 0.72

DISCUSSION

The present study shows that video demonstrations can be an equally effective teaching tool for URA construction teaching and learning when designed appropriately. Similarly, AlKahtani et al concluded that video demonstrations are viable alternatives to live demonstrations in dental education (12). There was no clear preference for either method. Students preferred RVD mainly for learning convenience and consistency of information, while FTFD was preferred mainly for better understanding. Literature has shown that both video and live demonstrations are effective in dental education and should be used together to achieve the maximum effect (12, 14, 19–23). Therefore, both FTFD and RVD have a place in the teaching and learning of orthodontic URA construction.

Students from the FTFD group had perceived themselves to be more competent in performing URA construction compared to the RVD group. However, when their work was assessed by orthodontists, students from the RVD group scored significantly higher than those from the FTFD group. This could be attributed to the fact that students from the RVD group had the benefit of rewatching the videos in addition to the convenience of learning at their own time and pace, whereas the students from the FTFD group were only given a single demonstration session for each component at a fixed time. This is in contrast with a study by Atik et al., where they found that subjects had equal competency in performing wire bending despite learning via live or video demonstrations (16).

This study found significant differences in perception of understanding between RVD and FTFD, where students felt FTFD helped them to understand the content better. This finding agrees with Packer et al. where their students felt that live demonstrations helped their understanding of the procedures (13). Nevertheless, several studies reported no difference in understanding between live and video demonstrations (15, 19, 24), while others concluded that video demonstrations were superior (14, 24, 25).

Students from the FTFD group rated RVD significantly higher than FTFD in terms of information consistency. Naturally, URA fabrication involves multiple consecutive steps which must be followed for optimal results. An advantage of video demonstrations is that information and instructions can be provided in a uniform and optimally structured way (15). The script and storyboard were planned meticulously, validated and reviewed by qualified orthodontists before being disseminated to the students. This would ensure that the information provided was accurate and ordered in an appropriate fashion. On the contrary, during FTFD, standardization in teaching of procedure is required, nevertheless, some variation in technique and information taught is unavoidable especially when involving more than one instructor. In addition, repetition of these demonstrations within a short space of time may cause 'teaching fatigue' (15). Videos are able to reduce the human error that might occur in FTFD such as unintentionally omitting certain parts of the demonstration that result from 'teaching fatigue'.

The use of RVD greatly facilitates self-learning at the students' own convenience. In the present study, students rated RVDs significantly higher in terms of learning convenience. These findings are consistent with those of a systematic review, which highlighted that video demonstrations offer improved accessibility and the advantage of repeatability (12). A study by Paechter and Maier found that students preferred online learning for flexibility in time, place and ability to self-regulation of learning processes (26). A study by Smith et al. investigating live and video demonstrations for ankle/foot examination techniques in medical students found that the video group reported greater study time (27). Another advantage of RVD is that the demonstration could be made available to students who are unavoidably absent from classes, reducing the need for repeat demonstrations, which would save time and manpower.

A significant advantage of RVD over traditional FTFD is visual clarity. The videos in this study were produced in Full HD quality, which provides excellent visualization of the entire process at a close-up distance afforded equally to all students. FTFD on the other hand had limited space which resulted in unequal vantage points of observation for each student. Beswick et al. believed that the increased visualization of practical procedures provided by videos led to increased performance by the subjects in their study (28).

A major drawback of learning through videos is the lack of direct communication between instructor and students, thus reducing learning opportunities. In the present study, students rated ‘understanding’ and ‘ability to learn’ higher for FTFD compared to RVD which may reflect the value of interaction with a knowledge-based individual in the case of an instructor. Students prefer live demonstrations as they value the opportunity to ask questions and interact directly with the instructor to clarify and reinforce content (17, 20, 29). Clearly, a balance must be struck between live and video teaching and learning to preserve the element of student-instructor interaction.

One solution to this is a combination of both methods, a live-video demonstration where the instructor performs the procedure, which is recorded at a close-up distance and viewed by students in real-time (19, 21). This method captures the immediacy of the procedure while also allowing for direct communication between instructors and students. However, the benefits of convenience and replayability must be sacrificed.

Another alternative is a ‘flipped classroom’ method whereby students will be instructed to watch videos prior to the physical class (30). A study by Lau et al. found that the ‘flipped classroom’ model was equally effective as the traditional live demonstration in transferring orthodontic wire bending skills for the fabrication of the Adams clasp (17). Subjects in the study perceived the arrangements in the ‘flipped classroom’ model were more conducive to learning (17). This further reinforces the notion that a blend of both video and physical classes would be most conducive to teaching and learning of orthodontic technical skills. Through this method, both the instructor-student interaction as well as the learning convenience are preserved.

The media-rich audio and visual stimulation that video provides covers a wide spectrum of learning preferences as outlined by the VARK analysis – Visual, Aural, Read/Write and Kinaesthetic (31). As such, the technical quality of the RVD plays a crucial role in its effectiveness in engaging a larger audience. Excellent audio and visual quality are paramount to enable students to accurately visualize the procedures portrayed while obtaining clear instruction via the instructor’s narration. The results of this study signify that students are content with the technical quality of the videos. One study reported that a visually appealing video was able to strengthen understanding of its content (20). Nevertheless, the technical quality of the videos is heavily dependent on the ability and skill of the instructors in recording and editing. Digital literacy of educators plays an important role in producing videos comparable to live demonstrations (20). There might be merit in collaborating with video producers to fabricate a visually tantalizing and factually accurate video.

Limitations

A limitation of this study is that the two groups were separated by cohort rather than randomly assigned within the same cohort, as FTFD were not permitted during the COVID-19 pandemic Once restrictions were lifted, FTFD was implemented for the subsequent cohort, and the comparison was made between these two distinct academic sessions. Furthermore, the number of sampel per cohort was also restricted by the intake number of 40 to 45 students per batch. Other than that, the present study did not evaluate students’ perception of the social aspect of learning, such as interaction with their peers and group discussions. Since learning is a multifaceted process, there might be value in investigating these aspects in relation to online or live teaching. Understanding the entire process of learning and optimizing it to suit students’ preferences should be a continuous process, as to produce knowledgeable, competent, and socially skilled graduates.

CONCLUSIONS

This study indicated that both RVD and FTFD are effective and relevant in the teaching and learning of orthodontic URA construction. Students preferred RVD for the aspect of information consistency and learning convenience, while FTFD for better understanding. FTFD and RVD complement each other’s strengths and weaknesses, and both have a place in the teaching and learning of orthodontic URA construction. Students perceived the videos to be of high audio and visual quality. In an ideal scenario both methods should be implemented in clinical teaching.

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