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*RESEARCH ARTICLE*

# EFFECTIVENESS OF BLENDED TEACHING METHOD IN TOOTH CARVING APPLIED IN PRECLINICAL COURSE OF DENTAL EDUCATION DURING THE COVID-19 PANDEMIC

**Zhanina Pavlova**
Associate Professor, Department of Prosthetic Dental Medicine, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria.

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## Abstract

**Background:** The knowledge of dental morphology is essential in every aspects of dental medicine. Tooth carving is useful for development of the manual skills and has positive influence on students' performance in clinical practice. In the extraordinary situation caused by the COVID-19 pandemic we needed to use innovative blended models in teaching of dental morphology.
**Te Aim of the** research was to perform comparative analysis of the teeth carved by students in preclinical courses in prosthetic dental medicine, tutored in two methods – conventional and blended, applied in the circumstances of the COVID-19 pandemic.
**Methodology:** Detailed evaluation of 381 carved teeth was done according to strictly defined criteria.
**Results:** The analysis of work of students tutored through blended method demonstrates good level of the skills for reproduction of dental morphology. The approximal and masticatory surfaces of the tooth crown and the teeth roots of premolars and molars were reproduced in better quality by the students in the course with blended tuition. The differences in realization of the criteria are in range of 5%. Statistical significance was established only in re-creation of the masticatory surfaces of molars ($p < 0.05$).
**Conclusion:**The blended model of tuition can be considered as effective educational model for tooth carving in courses of pre-clinics of prosthetic dental medicine. It would be purposeful for this practice to be combined with traditional educational methods in order to improve the tuition quality.



## Introduction:-

The COVID-19 pandemic brought about great challenges for the dental medicine tuition. The development of students' manual skills via practical tasks that they regularly perform is essential to the achievement of the necessary competences in each and every of the studied dental subjects (Machado et al., 2020).

**Corresponding Author:- Zhanina Pavlova**
Address:- Associate Professor,Department of Prosthetic Dental Medicine, Faculty of Dental Medicine, Medical University of Sofia, Bulgaria.

Even though the direct contact between lecturers and students is irreplaceable when assimilating the practical skills, we needed to formulate new rules and programs in this new extraordinary reality.Dental anatomy is main subject of the dental education, being one of the fundamental courses of the preclinical course curriculum (Kellesarian, 2018; Patil et al., 2015). The dental medicine students should have in-depth theoretic knowledge and skills in order to analyze and reproduce the shape, function and aesthetics of each and every tooth of human dentition (Siéssere et al., 2004). In their daily activity, the doctors of dental medicine perform recovery of the injured or lost dental tissues and the foundation for acquiring the necessary knowledge and psychomotor skills is created namely during the initial courses (Siéssere et al., 2004). During the tuition in Pre-clinics of prosthetic dental medicine, the practical exercises are essential part of the educational process, aimed at supporting the knowledge of dental anatomy in detail and developing students' manual skills (Chutinan et al., 2018). In order to achieve this objective, the students have practical classes in teeth carving at first course in order to acquire the necessary skills, as early as possible (Patel et al., 2018; Field et al., 2018). Theoretical lectures, two-dimensional teeth drawing, demonstrations by the lecturers of carving techniques, carving teeth out of soap or wax blocks are the conventional course components applied in numerous universities (Abu Eid et al., 2013; Anwar et al., 2020).

According to some opinions, the exercises for carving teeth are more suitable for the tuition of dental technicians (Ponniah, 2010). Nevertheless, the prevailing opinion is about the usefulness of these exercises and their positive influence on students' performance in clinical practice (Obrez et al., 2011; Nayak et al., 2014; Rishikesan et al., 2021; Pandarathodiyil et al., 2021).

The opportunity of computer-assisted tuition to supplement the educational process, especially in the case of insufficient curriculum hours is confirmed in the researches many years before the current situation caused by the COVID-19 pandemic (McCann et al., 2010; Kirkup et al., 2019; Lone et al., 2018). The main advantage of digital resources is the continuous access to information, no matter the time and place that allows flexible academic hours (De Azevedo et al., 2018; Nance et al., 2009; Al-Thobity et al., 2017).

In the blended educational models, we use a mixture of various educational resources such as atlases, manual demonstrations, video-lectures and educational videos, which produces significant improvement of students' skills in carving teeth (Obrez et al., 2011). Comparative studies show that the evaluations of teeth elaborated by students who studied in the blended models are higher than the ones of students tutored in the traditional manners (Al-Thobity et al., 2017; Chutinan et al., 2018; Alzahrani et al., 2019).

Despite the effective application of e-resources, the students prefer using them only as supplementation, not as full replacement of the traditional lectures (Rosenberg et al., 2003; McCann et al., 2010). As most preferred method they define the one where teeth are carving out step by step together with demonstration of the individual steps by a lecturer (Nikzad et al., 2012; Fayaz et al., 2015; Jeyapalan et al., 2016). It is reported that this approach yields the best results (Kilistoff et al., 2013; Anwar et al., 2020).

When carving teeth out of soap, the knowledge about dental morphology directly impact re-creation of the details, hence the analysis of practical work is a relevant method for evaluation of the tuition quality. The data accumulation from this kind of researches is useful for defining of the effectiveness of blended educational models in field of prosthetic dental medicine.

## Material and Methods:-

We evaluated a total of 381 teeth, carved out of soap, among three functional groups – upper left central incisor, lower left first premolar, upper left first molar. Teeth are part of the required practical work of students in the first course, studying Pre-clinics of prosthetic dental medicine in Faculty of Dental Medicine, Medical University of Sofia, Bulgaria.

195 teeth were made by 65 students (40 women and 25 men) tutored in the 1st course, winter semester of the academic 2019/2020 year via conventional methods of full attendance lecturing and laboratory practice. 186 teeth were made by 62 students (37 women and 25 men) tutored in the 1st course of the academic 2021/2022 year via blended methods of tutoring in the circumstances of COVID-19 pandemic.

**Inclusion criteria**:
Based on the available archive of the practical work, we selected teeth for evaluation that were made by students whose courses were tutored by one and the same lecturers; we selected one and the same teeth of a particular functional group (left teeth), in order to ensure comparison of results.

**Exclusion criteria:**
Teeth that doesn't meet the inclusion criteria.

The full attendance model includes lectures; demonstrations of carving each and every tooth in conformity with curriculum, presented live in the end of each lecture; demonstrations by the teachers during the laboratory exercises; opportunity to consult teacher during the exercises.

The blended tuition, applied recently in circumstances of the COVID-19 pandemics, includes presentation of lectures in virtual classroom; video demonstrations and hours of laboratory training reduced into half. The demonstrations were presented as video movies whereas carving the particular tooth is performed step by step by the teachers. It is accompanied by explanations on the applied technique and particularities in reproducing the specific morphological details. The videos remained with continuous online access so that the students could use them at any time and place unlimitedly.

In the present research, we evaluated retrospectively the carved teeth according to strictly defined criteria presented in table 1.

**Table 1:-** System and criteria for evaluation of the carved teeth.

| № | Criterion | Evaluated indicators | Points |
|---|---|---|---|
| **1** | Size of tooth | If the size of tooth is in conformity with the required size (ratio 1:3 compared to the natural teeth) | 10 |
| **2** | Vestibular surfaces of the tooth crown | Form of vestibular surface and expression of medial and distal edges | 10 |
| **3** | Lingual surfaces of the tooth crown | Form of lingual surface and expression of medial and distal edges | 10 |
| **4** | Medial aprocsimal surfaces of the tooth crown | Form of medial aprocsimal surface and expression of vestibular and lingual edge | 10 |
| **5** | Distal aprocsimal surface of the tooth crown | Form of distal aprocsimal surface and expression of vestibular and lingual edge | 10 |
| **6** | Cervical line curvatures | Position of cervical line curvature on vestibular and lingual surfaces of the tooth<br>Position of cervical line curvature on aproximal surfaces of the tooth | 10 |
| **7** | Height of contour | Location of the vestibular height of contour<br>Location of the lingual height of contour | 10 |
| **8** | Form of tooth roots | Shape of the roots | 10 |
| **9** | Position of tooth roots | Position of the roots toward tooth crown and tooth axis | 10 |
| **10** | Masticatory surfaces | Evaluation of elements depending on the functional group of the tooth | 10 |
| **Total points of evaluation** | | | **100** |
| **Correspondence between per cent satisfaction of the criterion and evaluation grades** | | | |
| <60%= 2 = "Unsatisfactory"; 60-69% = 3= "Satisfactory"; 70-79% = 4 = "Good"; 80-89% = 5= "Very good"; 90-100%= 6 = "Excellent" * | | | |

*In the Bulgarian educational system, evaluation is according to the six-point system.

Every criterion makes up 10% of the final tooth evaluation, whereas the maximum aggregate is 100 points. Every evaluation corresponds to particular per cent satisfaction of criteria defined in the table 1.

The incisal edge/masticatory surfaces were evaluated in detailed manner depending on the functional group of the tooth. The 10 points for criterion №10 was formed as sum of the points during evaluation of different components as they are presented inthe table 2.
In view of reducing the subjective mistake, the evaluation of teeth was performed by one and the same person – lecturer with more than 20 years of experience in teaching of dental medicine.

**Table 2:-** Evaluated elements of incisal edge/masticatory surfaces depending on the functional group of the tooth.

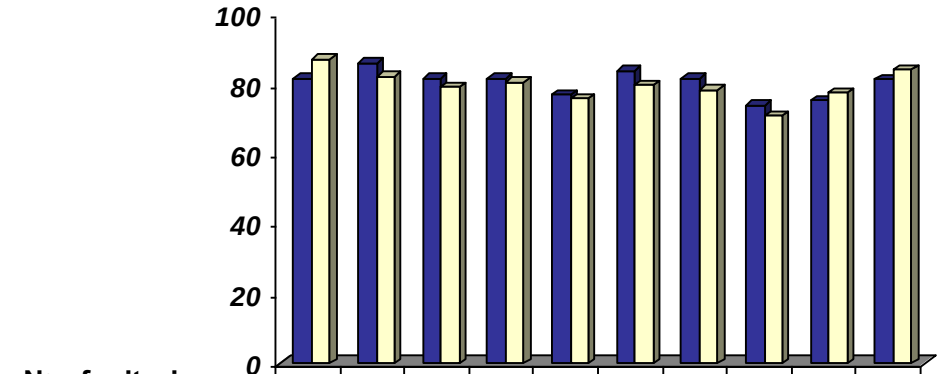
| **Evaluation of incisal edge/masticatory surfaces** | | | | | |
|---|---|---|---|---|---|
| **Incisor** | **Points** | **Premolar** | **Points** | **Molar** | **Points** |
| Labio-lingual location of the incisal edge | 4 | Location of the buccal cusp tip | 2 | Location of the buccal cusp tips | 2 |
| | | Location of the lingual cusp tip | 2 | Location of the lingual cusp tips; Cusp of Carabelli | 2 |
| Thickness of the incisal edge | 3 | Contour and location of medial and distal marginal ridges, and the triangular ridges | 4 | Contour and location of medial and distal marginal ridges, and the triangular ridges; oblique ridge; transverse ridge | 4 |
| Form of incisal edge | 3 | Contour and location of medial and distal triangular fossae, the central developmental groove | 2 | Contour and location of medial and distal triangular fossae, the central developmental groove and medial marginal developmental groove | 2 |
| **Total points for criterion №10** | 10 | | 10 | | 10 |

**Statistical Methods:**
The data were statistically processed using Microsoft Excel – 2016. It was performed: descriptive analysis - mean and standard deviation were calculated for the scores; t-test and paired t-test for the evaluation of differences with selected significance level $\alpha = 0.05$ ($p<0.05$).

## Results:-

In this research were compared the per cent satisfaction of each and every criterion for the evaluated teeth, the most common mistakes made by students, average grades for the courses and their share distribution.
In order to evaluate the degree of mastering the morphological features of carved teeth, was analyzed the per cent realization of each and every criterion for the evaluated teeth. The differences in the performance of various criteria vary from 0.5 to 8.26%, yet not in all cases these are in the interest of the course with traditional tuition**(Fig. 1)**.

**Fig.1. Per cent realization of every criterion for the evaluated incisors**



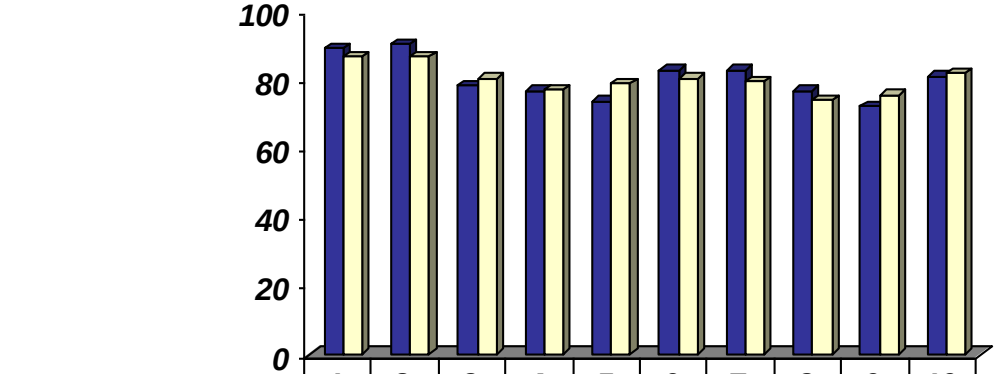

| № of criterion | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| traditional tuition | 81.5 | 86.2 | 81.5 | 81.5 | 76.9 | 83.8 | 81.5 | 73.9 | 75.4 | 81.2 |
| hybrid tuition | 87.1 | 82.3 | 79 | 80.6 | 75.8 | 79.8 | 78.2 | 71 | 77.4 | 84.2 |

When analyzing the data about the sculptured incisors, at seven of the researched criteria (№№ 2,3,4,5,6,7 and 8) we observe differences between 0.9% and 4%, whereas the higher per cent realization is found in the course with full attendance tuition**.**

Nevertheless, under three of the criteria concerning the dental dimensions, the position of root and the shape of incisal edge we find better performance in the course with blended tuition, with 5.55%, 2.04 and 2.96% correspondingly.

In the sculptured premolars, about five of the researched criteria (№№ 1, 2, 6, 7 and 8) we also observe higher per cent satisfaction in the course with full attendance tuition, whereas the differences are between2.14% and 3.67% **(Fig. 2).**

**Fig. 2. Per cent realization of every criterion for the evaluated premolars**

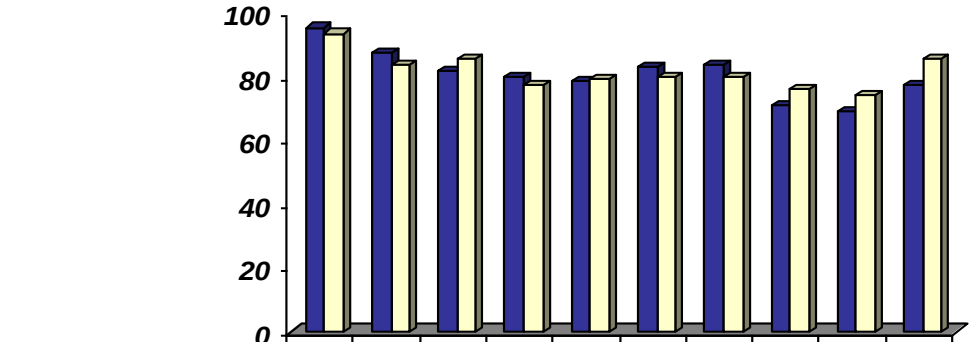



| № of criterion | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| traditional tuition | 89.2 | 90.8 | 78.5 | 76.9 | 73.9 | 83.1 | 83.1 | 76.9 | 72.3 | 81.2 |
| hybrid tuition | 87.1 | 87.1 | 80.6 | 77.4 | 79 | 80.6 | 79.8 | 74.2 | 75.8 | 82.3 |

We found the re-creation of lingual, approximal surfaces, root position and the elements of the masticatory surface of the premolars, being better in the course with blended tuition, even though with small differences between 1% and 5%.

In the elaborated molars at five of the researched criteria (№№ 1, 2, 4, 6 and 7) we observe differences between1.84% and 4.01%, whereas better performance is observed in the course with traditional tuition **(Fig. 3).**

**Fig. 3. Per cent realization of every criterion for the evaluated molars**




| № of criterion | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| traditional tuition | 95.4 | 87.7 | 81.5 | 80 | 78.5 | 83.1 | 83.9 | 70.8 | 69.2 | 77.4 |
| hybrid tuition | 93.5 | 83.9 | 85.5 | 77.4 | 79 | 79.8 | 79.8 | 75.8 | 74.2 | 85.6 |

The other five elements – shaping up the lingual and approximal surfaces of the tooth crown, form and position of teeth roots and the masticatory surfaces are reproduced in better quality by the students in the course with blended tuition.

The average grades for both courses are within the interval of 79-82 points that corresponds to grade "Very good-5". There is no significant difference between grades of teeth made by men and women – $p>0.05$ for teeth of all the researched functional groups.The share distribution of the grades of evaluated teeth in two courses shows that the share of"Unsatisfactory" grades is below 2% in both courses – 1.59% for the course with traditional tuition and 1.94% for the course with blended tuition correspondingly. The share of "Satisfactory" grades is 11.28% for the course with attendance tuition and 9.68% – for the one with blended. The share of grades "Good" is 35.48% for the course with attendance tuition and 28.20% – for the one with blended. The grades "Very good" have a share of 37.43% for the course with attendance tuition and 34.946% – for the one with blended. The share of "Excellent" grades is 23.07% for the course with attendance tuition and 19.89% – for the one with blended.

## Discussion:-

The specificity of prosthetic dental medicine requires continuous demonstration of various techniques and direct observation of students' work by the lecturer. In this process, the direct communication between students and teachers, whereas the students are provided with the opportunity to ask questions and get feedback in timely manner about their knowledge and practical work is essential. The achievement of optimal results could hardly be realized in the circumstances of entirely distance teaching. Hence when adapting the teaching methods in the pandemic circumstances we looked for hybrid models that are capable to provide the right balance between the distance and attendance tuition. The analysis of students' practical work whereas these students are being tutored in these circumstances would allow us to evaluate and strong and weak points of the blended tuition system. This kind of analysis helps us to establish the effectiveness of blended method regarding the practical skills acquired during the course of pre-clinic of prosthetic dental medicine.

The analysis results show that both approaches of teaching provide almost equivalent tuition level concerning the practical work in this preclinical semester. The differences found in the per cent satisfaction of criteria by both courses are without statistical significance – $p>0.5$ for each and every of them, with single exception – the preparation of the masticatory surfaces of molars.

Another researched issue was whether there is difference in assimilating and reproducing of the morphological dental features. The analysis of students' practical work shows the following: Most often errors are made in shaping up the roots, irrespective of the tuition method. In the course with attended tuition, the inaccurate root shaping is found in 26% of incisors, in 23% of premolars and in 29% of molars. In the course with blended tuition, errors when shaping up the roots were made in 29 % of incisors, in 25% of premolars and in 24% of molars. What impresses us is that in the course of blended tuition fewer errors (in about 5% of the molars) were made when shaping up the molar roots, compared to the ones in the full attendance course, despite the greater complexity of the morphology of three-root teeth, like the first upper molar. These results confirm the data found in literature that the students face the greatest difficulties when reproducing roots of teeth with numerous roots (Nance et al., 2009). The data of the present research show that the reason is most likely related to the specific nature of the morphological features than to the teaching methods. The interactive elements of blended tuition, in the pattern of video-demonstrations are actually useful when overcoming the difficulties related to carving the dental roots.

In the case of premolars one more element is outstanding where errors were made and this is the accurate reproduction of aproximal walls. In around 1/5 of the sculptured premolars we observe imprecision in shaping up and expression of the vestibular and lingual contour and edges. This type of error was made in 24% of premolars, carved by the students in course of attended tuition and in 21% of the ones carved in course of blended tuition.

In the course with traditional tuition, most frequently errors were established in re-creation of various details of the masticatory surface of molars – most often when reproducing the oblique ridge, transverse ridge and the Cusp of Carabelli. This kind of errors were observed in around 1/5 (22%) of carved molars. In the course with blended tuition, the errors made when reproducing the masticatory surface of molars are with 8.29% lower. It is interesting to mention that namely the masticatory surface of the first upper molar, component that includes numerous details and has greater complexity of elaboration, is prepared in better precision by the students in blended tuition. The probable reason behind this is the unlimited access to video films with the demonstrations prepared by the teachers. Whereas in the traditional tuition students see this demonstration once while attending the lecture, in the hybrid system they could play repeatedly the videos with demonstrations of carving the particular tooth, stop or replay the recording of various stages and compare the quality of the teeth made by them with the ones on screen. The included in videos explanations help not only for better understanding of carving methods but also for reinforcement of the theoretical knowledge about teeth morphology. The results obtained in present research confirms the opinion shared by Nance et al. (2009) that via hybrid teaching methods including digital technologies as assisted help, we could achieve good results in the practical work, despite the morphological complexity of the tooth being carve out.

Despite the reduced academic hours for attended laboratory practice, in the course with blended tuition we didn't find significant omissions in reflecting the main characteristics and details when carving teeth. The analysis demonstrates sufficiently good level of utilizing the knowledge about the dental morphology and the practical skills for its reproduction, which is comparable to providing the students of the course with traditional tuition before the pandemics. The results of the present research confirm the opinion of numerous authors on the purposefulness of implementing innovative methods for teaching dental morphology(Lone et al., 2018; Risnes et al., 2019). The share distribution of grades also confirms this opinion. It shows that the share of "Satisfactory" grades in blended tuition is 1.6% lower compared to the traditional tuition. More significant difference is observed in the shares of grades "Good" – in the course with blended tuition, their share is 7.28% higher, and the share of grades "Very good" is 2.49% lower compared to the course with traditional tuition. Based on the data we could see that in the course with blended tuition the highest numbers of teeth were graded as "Good". Nevertheless, the share of grades "Very good" and "Excellent" also remains high and we observe comparable proportion of grade distribution in both courses. The differences in share distribution of grades didn't show statistical significance – $p > 0.05$.

The applied system for evaluation has been tried in practice many times and has proven its effectiveness for evaluation of the carved teeth in detail. This manner of evaluation makes it possible to differentiate the most common mistakes made by students and undertake actions for their reduction. Information about the aspects of tooth morphology that hinder the students during tooth carving helps the lecturers in directing their efforts so that a

possible deficit of students' knowledge could be easily overcome. The accumulation of knowledge about the qualities of students' work, in different tutoring circumstances, is a foundation for the development of innovative teaching methods and the improvement of curricula.

The successful completion of the practical work in the established terms confirms the opinion that the continuous access to information provided by the digital resources allows flexible academic hours and making up for the insufficient hours for attended tuition(Nance et al., 2009; Juneja et al., 2016). We sustain the opinion shared by other authors that despite the effective application of digital resources, these should be used only as a supplement, not as comprehensive replacement of traditional lecturing (McCann et al., 2010).

## Conclusion:-

The blended pattern of tuition, applied during the COVID-19 pandemic can be considered as effective educational model for tooth carving in courses of pre-clinics of prosthetic dental medicine. By this method was achieved sufficiently good level of utilizing the knowledge about the dental morphology and the practical skills for its reproduction, which is comparable to these of the students tutored in the course with traditional methods before the pandemic. Provided students with continuous online access to the digital lectures and demonstrations, prepared by teachers, facilitate the educational process. The integration of digital resources used during the blended tuition in the traditional methodologies would bring about optimization of the academic curricula and improvement of the tuition quality.

**Conflicts of Interest:**
The author declares no potential conflicts of interest with respect to the research, authorship and publication of this article.

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## References:-

1. Abu Eid, R., Ewan, K., Foley, J., Oweis, Y. and Jayasinghe, J. (2013): Self-directed study and carving tooth models for learning tooth morphology: perceptions of students at the University of Aberdeen, Scotland. J. Dent. Educ., 77(9):1147-1153.
2. Al-Thobity, A.M., Farooq, I. and Khan, S.Q. (2017): Effect of software facilitated teaching on final grades of dental students in a dental morphology course. Saudi Med. J., 38(2):192-195.
3. Alzahrani, A.A., Alhassan, E.M., Attia, M.A. and Albanghali, M. A.(2019): Enhancing dental carving skills of preclinical dental hygiene students using online dental anatomy resources. Open Dent. J., 13:499-504.
4. Anwar, M., Alam, B.F. and Zaidi, S.J.A. (2020): Tooth carving as a teaching modality in the study of tooth morphology: Students' perception and performance. J. Pak. Dent. Assoc., 29(04):249-253.
5. Chutinan, S., Riedy, C.A. and Park, S.E. (2018): Student performance in a flipped classroom dental anatomy course. Eur. J. Dent. Educ., 22(3): e343–e349.
6. De Azevedo, R.A., Correa, M.B., Torriani, M.A. and Lund, R.G. (2018): Optimizing quality of dental carving by preclinical dental students through anatomy theory reinforcement. Anat. Sci. Educ., 11(4):377-384.
7. Fayaz, A., Mazahery, A., Hosseinzadeh, M. and Yazdanpanah, S. (2015): Video-based learning versus traditional method for preclinical course of complete denture fabrication. J Dent., 16(1 Suppl) :21-28.
8. Field, J., Stone, S., Orsini, C., Hussain, A., Vital, S., Crothers, A. and Walmsley, D. (2018): Curriculum content and assessment of preclinical dental skills: A survey of undergraduate dental education in Europe. Eur. J. Dent. Educ., 22(2):122-127.
9. Haj-Ali, R., Walker, M.P., Petrie, C.S. and Steven, J. (2007): Educational necessities to compensate for faculty shortage. J. Dent. Educ., 71(4):511-515.
10. Jeyapalan, K., Mani, U.M., Christian, J., Seenivasan, M.K., Natarajan, P. and Vaidhyanathan, A.K. (2016): Influence of teaching strategies and its order of exposure on pre-clinical teeth arrangement – A pilot study. J. Clin. Diagn. Res., 10(10): ZC93-ZC97.
11. Juneja, S. and Juneja, M. (2016): Role of computer-based learning in tooth carving in dentistry: An Indian perspective. Int. J. App. Basic. Med. Res., 6(3):164-165.
12. Kellesarian, S.V. (2018): Flipping the dental anatomy classroom. Dent. J. (Basel).; 6(3):23.doi: 10.3390/dj6030023.

13. Kilistoff, A.J., Mackenzie, L., D'Eon, M. and Trinder K. (2013): Efficacy of a step-by-step carving technique for dental students. J. Dent. Educ., 77(1):63-67.
14. Kirkup, M.L., Adams, B.N., Reifeis, P.E., Heselbarth, J.L. and Willis, L.H. (2019): Is a picture worth a thousand words? Effectiveness of ipad technology in preclinical dental laboratory courses. J. Dent. Educ., 83(4):398-406.
15. Lone, M., McKenna, J.P., Cryan, J.F., Downer, E.J. and Toulouse, A. (2018): A survey of tooth morphology teaching methods employed in the United Kingdom and Ireland. Eur. J. Dent. Educ. 22(3): e438–443.
16. Machado, R.A., Bonan, P.R.F., Perez, D.C. and Martelli, H. Júnior. (2020): COVID-19 pandemic and the impact on dental education: Discussing current and future perspectives. Braz. Oral Res., 34: e083 doi: 10.1590/1807-3107.
17. McCann, A.L., Schneiderman, E.D. and Hinton, R.J. (2010): E-teaching and learning preferences of dental and dental hygiene students. J. Dent. Educ., 74(1) :65-78.
18. Nance, E.T., Lanning, S.K. and Gunsolley, J.C. (2009): Dental anatomy carving computer-assisted instruction program: an assessment of student performance and perceptions. J. Dent. Educ., 73(8): 972-979.
19. Nayak, M.T., Sahni, P., Singhvi, A. and Singh, A.H.(2014): The perceived relevance of tooth carving in dental education: Views of practicing dentists and faculty in West India. Educ. Health, 27(3):238-242.
20. Nikzad, S., Azari, A., Mahgoli, H. and Akhoundi, N. (2012): Effect of a procedural video CD and study guide on the practical fixed prosthodontic performance of Iranian dental students. J Dent Educ., 76(3):354-359.
21. Obrez, A., Briggs, C., Buckman, J., Goldstein, L., Lamb, C. and Knight, W.G. (2011): Teaching clinically relevant dental anatomy in the dental curriculum: description and assessment of an innovative module. J. Dent. Educ., 75(6):797-804.
22. Pandarathodiyil, A.K., Priyadarshini, H.R., Daud, S., Islam, M.N. and Monerasinghe, E. (2021): Perception and attitude regarding the relevance of tooth morphology carving exercises: A malaysian undergraduate dental students perspective. J Int. Dent. Med. Res., 14(2): 660-665.
23. Patel, U.S., Tonni, I., Gadbury-Amyot, C., Van der Vleuten, C.P.M. and Escudier, M. (2018): Assessment in a global context: an international perspective on dental education. Eur. J Dent. Educ., 22(Suppl 1):21-27.
24. Patil, S., Sowmya, S.V., Rao, R.S. and Raj, T.A. (2015): Knowledge, attitude and practice of tooth morphology among dental students. J. Adv. Clin. Res. Insights., 2:124-130.
25. Ponniah, I. Why tooth carving? (2010): Indian J. Dent. Res.;21(3):463.
26. Rishikesan, M., Krishnan, R.P. and Sundar, S. (2021): Knowledge, perception & attitude regarding tooth carving among dental students. Nat. Volatiles & Essent. Oils., 8(5):8644-8656.
27. Risnes, S., Khan, Q., Hadler-Olsen, E. and Sehic, A. (2019): Tooth identification puzzle: a method of teaching and learning tooth morphology. Eur. J. Dent. Educ., 23 (1):62-67.
28. Rosenberg, H., Grad, H.A. and Matear, D.W. (2003): The effectiveness of computer-aided, self-instructional programs in dental education: a systematic review of the literature. J. Dent. Educ., 67(5):524-532.
29. Siéssere, S., Vitti, M., de Sousa, L.G., Semprini, M. and Regalo, S.C.H. (2004): Educational material of dental anatomy applied to study the morphology of permanent teeth. Braz. Dent. J., 15(3): 238-242.