The Effects of Traditional and Step-By-Step Education Protocols on the Quality of Class IV Composite Restorations Performed by Preclinical Dental Students

Geleneksel ve Kademeli Eğitim Protokollerinin Diş Hekimliği Preklinik Öğrencileri Tarafından Gerçekleştirilen Sınıf IV Kompozit Restorasyonların Kalitesi Üzerindeki Etkileri

Nasibe Aycan YILMAZ https://orcid.org/0000-0001-5939-8170
Hülya ERTEN https://orcid.org/0000-0001-7823-7145

Dokuz Eylul University, Faculty of Dentistry, Department of Restorative Dentistry, Izmir

Citation: Yılmaz NA, Erten H. The Effects of Traditional and Step-By-Step Education Protocols on the Quality of Class IV Composite Restorations Performed by Preclinical Dental Students. *Int Arc Dent Sci.* 2026; 47(1): 33-40.

ABSTRACT

INTRODUCTION: This study aimed to evaluate the effect of traditional and step-by-step education protocols on the quality of Class IV direct composite resin restorations performed by preclinical students.

MATERIAL and METHODS: A hundred and twenty dental students enrolled in their third year (56 females, 64 males) were included in the study and allocated to the traditional (control) or step-by-step education (experimental) group using stratified randomization (28 females, 32 males, n=60). Following the relevant education protocol, all students performed class IV composite restorations using the silicon index technique on the pre-fractured artificial upper incisor. The quality of the restorations was evaluated double-blindly and scored according to the restoration parameters. The data were statistically analyzed with the Mann-Whitney U test at a significance level of α<0.05.

RESULTS: The step-by-step education group performed better than the traditional group (p<0.05) regarding the palatal and labial morphology, marginal adaptation, and finishing/polishing parameters. The quality of the restorations in both groups was similar regarding the void formation and color transition parameters (p>0.05).

CONCLUSION: Students in the step-by-step education group created more successful restorations than their peers in the traditional group. The step-by-step education method may be a promising one for increasing student success in skills training.

Keywords: *Dental education, composite resin, dental restoration*

ÖZ

GİRİŞ: Bu çalışmanın amacı, geleneksel ve kademeli eğitim protokollerinin preklinik öğrencileri tarafından silikon indeks tekniği kullanılarak yapılan Sınıf IV direkt kompozit rezin restorasyonların kalitesi üzerindeki etkisini değerlendirmektir.

YÖNTEM ve GEREÇLER: Çalışmaya üçüncü sınıfa kayıtlı yüz yirmi diş hekimliği öğrencisi (56 kadın, 64 erkek) dahil edilmiştir. Öğrenciler tabakalı randomizasyon kullanılarak geleneksel eğitim (kontrol) veya kademeli eğitim (deney) grubuna ayrılmıştır (her grupta 28 kadın, 32 erkek, n=60). Öğrenciler ilgili eğitim protokolü dahilinde, standart şekilde kırık simülasyonu oluşturulmuş fantom üst kesici dişlere silikon indeks yöntemiyle sınıf IV direkt kompozit rezin restorasyon uygulamışlardır. Kompozit rezin restorasyonların kalitesi çift kör olarak değerlendirilerek palatal ve labial morfoloji, marjinal adaptasyon, restoratif materyalde boşluk oluşumu, renk geçişi ve bitim/cila gibi restorasyon parametrelerine göre skorlanmıştır. Veriler istatistiksel olarak α<0.05 anlamlılık düzeyinde Mann-Whitney U testi ile analiz edilmiştir.

BULGULAR: Kademeli eğitim grubundaki öğrenciler, geleneksel eğitim grubundakilere kıyasla palatal ve labial morfoloji, kenar uyumu ve bitim/cila kriterleri açısından daha başarılı restorasyonlar oluşturmuşlardır (p<0,05). Restoratif materyalde boşluk oluşumu ve renk geçişi kriterleri açısından iki gruptaki restorasyonların kalitesi benzerdir (p>0,05).

SONUÇ: Genel olarak, kademeli eğitim grubundaki öğrenciler, geleneksel eğitim grubundaki akranlarına kıyasla daha başarılı restorasyonlar oluşturmuşlardır. Kademeli eğitim yöntemi beceri eğitiminde öğrenci başarısını arttırabilecek umut vaat edici bir eğitim yöntemi olabilir.

Anahtar Kelimeler: *Anahtar Sözcükler: Dental eğitim, kompozit rezin, dental restorasyon*

Corresponding author: dt.aycanyilmaz@yahoo.com
Received Date: 08.02.2025
Accepted Date: 14.08.2025

INTRODUCTION

Dentistry is a practical discipline highly based on manual dexterity. Dental education plays a vital role in developing manual skills [1]. A successful education system should enable the instructor to understand multiple education methods and meet the student's learning demands [2]. Considering growing evidence of the effects of teaching methods on the quality of education, teaching strategies in dental education have also been questioned [3-5]. It is emphasized that the traditional education system in today's dentistry should be strengthened with innovative methods [6].

The preclinical term constitutes the backbone of the undergraduate dental education system. During preclinical education, dental students start learning all the techniques from the basics until they master the necessary practices [7]. The traditional instructor-centered education is the oldest and most widely applied dental education model in which the instructor directly controls the transfer of knowledge and the demonstration of skill practice [8]. Traditional preclinical restorative dentistry education consists of successive course steps. First, the instructor presents the theoretical lecture, and then the practical demonstration. Finally, the student is expected to remember all the stages from the beginning to the end and then practice the skill. In traditional, all-in-one education, dental students must learn and master all the skills at once. However, when students encounter intricate multistep procedures such as a direct Class IV composite resin restoration, the teaching effectiveness of the traditional education method may decrease due to overwhelming complexity. A series of dental materials and instruments are used at each stage of such a restoration procedure, which may lead to confusion and be challenging for preclinical dental students [9].

Recently, student-centered approaches in dentistry education that encourage students to participate actively in learning have been popular [10]. More recently, an innovative instructor-student interactive education model, the step-by-step education method, has been introduced in dental education [9, 11, 12]. This novel teaching method combined instructor-centered and student-centered approaches [8].

The step-by-step education method has emerged as a promising approach to enhancing the learning outcomes of dental students. It involves breaking down complex procedures into manageable, sequential tasks. By focusing on individual steps, students can master each procedure component before moving on to the next, reducing the likelihood of errors in the step-by-step education method. Several studies have demonstrated the practical application of step-by-step learning in various dental education settings. Nonetheless, there appears to be a dearth of literature on the step-by-step education method. Therefore, this study aimed to evaluate the effect of traditional and step-by-step education protocols in dental preclinical skills practice on the students' performance on direct Class IV resin restoration with the silicon index technique. The null hypothesis was that no difference would exist between students' performance receiving two different educational protocols on direct Class IV composite resin restoration skill practice.

MATERIALS and METHODS

Grouping of the students

This study was carried out upon the approval of the local ethics committee of Aydın Adnan Menderes University Non-Interventional Clinical Research Ethics Committee (Approval No: 2022/02-05). The minimum sample size was calculated using G*Power (V.3.1.9.4; Heinrich Heine University of Dusseldorf, Dusseldorf, Germany). Based on previous research [9], with a 95% confidence (1-α), 95% test power (1-β), and d=0.939 effect size, it was determined that a minimum of 31 students in each group (62 students in total) should be included in the study. However, 120 preclinical students (56 females, 64 males) enrolled in the third year of Aydın Adnan Menderes University Faculty of Dentistry in the 2022-2023 academic year volunteered to participate in the study. Through stratified randomization, female and male students were distributed randomly and equally into two groups by having the female students drawn from the sealed red envelopes and the male students from the blue ones. Thereby, the students were allocated either to the traditional education (control) group [n=60 (28 females, 32 males)] or to the step-by-step education (experimental) group [n=60 (28 females, 32 males)].

Each artificial tooth model was assigned a sample/student number using a simple random sampling method through an online research randomizer software (https://www.randomizer.org). An independent investigator filled out Data Form-1 by recording the sample/student number, the group, and the student's gender, and kept it without sharing it with researchers until the statistical analysis data entry stage.

Pre-course preparations

The instructor ensured the standardization of the restorative materials, pre-fractured artificial teeth, and silicon indexes for the skill practice of preclinical students under both education protocols.

Clearfil Majesty Esthetic composite resin (shades A1, A2, and OA2, Kuraray Medical Co., Tokyo, Japan), Filtek Ultimate Flowable Restorative composite resin (shade OA3, 3M ESPE, St. Paul, MN, USA), K-Etchant etching gel (Kuraray Medical Co, Tokyo, Japan), and Optibond Universal adhesive resin (Kerr Corporation, Orange, CA, USA) materials were allocated for each student to be used for the direct Class IV composite resin restoration with the silicone index technique.

Before simulating the anterior tooth fracture, the instructor created a palatal index for each intact artificial model using a silicone impression material (Zetaplus, Zhermack, Italy). Afterward, a standard-sized oblique tooth fracture was prepared on each artificial right maxillary incisor using a diamond bur attached to a high-speed aerator under water cooling. At the end of the relevant procedure, an unbiased, blind researcher verified the suitability of the silicon indexes and the standardization of pre-fractured artificial teeth.

The independent investigator delivered restorative materials, pre-fractured artificial teeth, and silicone indexes to the students in transparent Ziplock refrigerator bags. Except for the sample/student number, no information about the student's identity or group was present on the delivery bags or specimens.

Organization of the course

Before the lesson, the instructor informed all students that the course content was the same in both groups, yet the educational methods differed. Thereafter, the instructor collected voluntary informed consent.

The students in the traditional education group attended the preclinical laboratory between 08:30 and 10:00 hours, and those in the step-by-step education group between 10:30 and 12:00. Using this arrangement, we planned that there would be no communication about the novel education method between the students in both groups as much as possible. Optimal working conditions were provided for both groups, and the students' time of entry to the clinic was considered when the evaluation was made.

One instructor accomplished all theoretical lectures and skill practice demonstrations in both groups. The lesson was broadcast live to the students through the audiovisual equipment mounted on the instructor’s and students’ desks. Thereby, the students simultaneously followed the lecture presentation and practical demonstration.

Class IV composite resin restoration with the silicone index technique on the artificial tooth model included the following demonstration steps: 1- Create a silicone palatal index on the intact artificial model. 2- Simulate the anterior tooth fracture by preparing the right incisor with an aerator. 3- Bevel the labial margin and smooth the sharp irregularities. 4- Perform the adhesive procedures. 5- Reconstruct the palatal wall, approximal contours, and incisal edges. 6- Use various composite resin materials with different shades and opacities and complete the restoration with the incremental technique. 7- Finishing and polishing.

In the traditional education protocol (control group), the instructor completed the theoretical presentation and performed all practical demonstrations in a single session without a break. Afterward, the students were allowed to perform all related restoration steps from the beginning to the end to fulfill the skill practice. In the step-by-step education protocol (experimental group), the triad composed of the instructor's theoretical presentation, practical demonstration, and student’s skill practice was repeated successively in each step of the restorative procedure. The restoration procedures related to the isolation and composite shade selection were mentioned only in the theoretical presentation, as these would only be valid while practicing on human teeth in the clinical setting, not artificial teeth of standard color.

As the instructor standardized the first two steps of the restoration procedure, the students were enabled to perform the restoration steps following the second step. At the end of the study, all students delivered the artificial teeth they restored to the independent investigator by putting them back in their refrigerator bags. The independent investigator mixed the specimens in an empty cardboard box before giving them to the researchers.

Evaluation of the quality of the restorations

Two researchers with at least ten years of experience in the specialty of restorative dentistry performed a double-blind evaluation for the direct Class IV composite resin restorations applied by the students under both educational protocols. Evaluation criteria consisted of different restoration parameters, which are palatal and labial morphology, marginal adaptation, void formation, color transition, and finishing/polishing. When scoring each parameter, the investigators gave a Score 2 to a successfully completed parameter, a Score 1 to a clinically acceptable parameter that might be improved further with simple corrections, and a Score 0 to a clinically unacceptable parameter that would necessitate the replacement of the restoration (Table 1). The scoring system used in this study is based on an institutional method that has been routinely applied in preclinical restorative dentistry education at our faculty. The instructors developed, discussed, and periodically revised it to suit educational needs and provide a consistent, pedagogically relevant assessment of student performance. A similar approach has also been reported in previous literature [9], where the scoring was based on a traditional system used in institutional education and revised by specialists and teaching faculty.

Keeping up with the sample number, the researchers recorded the evaluation score for each parameter in Data Form 2. If there was a discrepancy in the scores, both researchers re-evaluated the relevant criteria until they reached a consensus.

Table 1. Scoring criteria for restoration parameters.

	Scoring Criteria		
	Score 2	**Score 1**	**Score 0**
Palatal Morphology	Successful The palatal form closely replicates the natural anatomical morphology.	Clinically acceptable The palatal form demonstrates a clinically acceptable adaptation to the anatomical form, with slight modifications and polishing required for optimal integration.	Clinically unacceptable The restoration's palatal form is inconsistent with the natural anatomical morphology.
Labial Morphology	Successful The labial form closely replicates the natural anatomical morphology.	Clinically acceptable The labial form demonstrates a clinically acceptable adaptation to the anatomical form, with slight modifications and polishing required for optimal integration.	Clinically unacceptable The restoration's labial form is inconsistent with the natural anatomical morphology.
Marginal Adaptation	Successful The restoration margins are well-adapted, with no detectable irregularities upon exploration with a dental probe.	Clinically acceptable The restoration margins are well-adapted, with slight irregularities that can be eliminated by repetition of finishing/polishing.	Clinically unacceptable The dental explorer catches at the margins of the restoration, indicating marginal discrepancies or overhangs.
Void Formation	Successful No void exist	Clinically acceptable Voids exist that can be eliminated by repetition of finishing/polishing.	Clinically unacceptable Voids exist that cannot be eliminated by repetition of finishing/polishing
Color Transition	Successful Smooth color transition at the restoration-tooth interface.	Clinically acceptable color transition at the restoration-tooth interface that can be further improved with minimal repetition of finishing/polishing.	Clinically unacceptable sharp color transition.
Finishing Polishing	Successful There is no roughness in probing at the restoration-tooth interface.	Clinically acceptable slight roughness that can be eliminated by repetition of finishing/polishing.	Clinically unacceptable roughness that requires restoration replacement.

Table 2. The frequency of the scores for the evaluation parameter of palatal morphology.

	Palatal Morphology				
Education Protocol	**Scoring**	**Female**	**Male**	**Total Count (n)**	**Percent (%)**
Traditional	Score 0	2	1	3	5.0
	Score 1	10	18	28	46.7
	Score 2	16	13	29	48.3
	Total	28	32	60	
Step-by-Step	Score 0	0	0	0	0.0
	Score 1	6	7	13	21.7
	Score 2	22	25	47	78.3
	Total	28	32	60	
Total	Score 0	2	1	3	2.5
	Score 1	16	25	41	34.2
	Score 2	38	38	76	63.3
	Total	56	64	120	

The step-by-step education protocol was significantly different from the traditional education protocol for the palatal morphology parameter *($p<0.001$).*

Table 3. The frequency of the scores for the evaluation parameter of labial morphology.

Labial Morphology					
Education Protocol	**Scoring**	**Female**	**Male**	**Total Count (n)**	**Percent (%)**
Traditional	Score 0	4	7	11	18.3
	Score 1	12	15	27	45.0
	Score 2	12	10	22	36.7
	Total	28	32	60	
Step-by-Step	Score 0	0	1	1	1.7
	Score 1	10	9	19	31.7
	Score 2	18	22	40	66.7
	Total	28	32	60	
Total	Score 0	4	8	12	10.0
	Score 1	22	24	46	38.3
	Score 2	30	32	62	51.7
	Total	56	64	120	

The step-by-step education protocol was significantly different from the traditional education protocol for the labial morphology parameter *(p<0.001)*.

Table 4. The frequency of the scores for the evaluation parameter of marginal adaptation.

Marginal Adaptation					
Education Protocol	**Scoring**	**Female**	**Male**	**Total Count (n)**	**Percent (%)**
Traditional	Score 0	4	7	11	18.3
	Score 1	6	11	17	28.3
	Score 2	18	14	32	53.3
	Total	28	32	60	
Step-by-Step	Score 0	0	1	1	1.7
	Score 1	10	9	19	31.7
	Score 2	18	22	40	66.7
	Total	28	32	60	
Total	Score 0	4	8	12	10.0
	Score 1	16	20	36	30.0
	Score 2	36	36	72	60.0
	Total	56	64	120	

The step-by-step education protocol was statistically different from the traditional education protocol for the marginal adaptation parameter *(p=0.043)*.

Table 5. The frequency of the scores for the evaluation parameter of void formation.

Void Formation					
Education Protocol	**Scoring**	**Female**	**Male**	**Total Count (n)**	**Percent (%)**
Traditional	Score 0	2	1	3	5.0
	Score 1	2	10	12	20.0
	Score 2	24	21	45	75.0
	Total	28	32	60	
Step-by-Step	Score 0	0	1	1	1.7
	Score 1	3	3	6	10.0
	Score 2	25	28	53	88.3
	Total	28	32	60	
Total	Score 0	2	2	4	3.3
	Score 1	5	13	18	15.0
	Score 2	49	49	98	81.7
	Total	56	64	120	

The step-by-step education protocol and traditional education protocol were statistically similar for the void formation parameter *(p=0.058)*.

Table 6. The frequency of the scores for the evaluation parameter of color transition.

		Color Transition			
Education Protocol	**Scoring**	**Female**	**Male**	**Total Count (n)**	**Percent (%)**
Traditional	Score 0	3	6	9	15.0
	Score 1	10	15	25	41.7
	Score 2	15	11	26	43.3
	Total	28	32	60	
Step-by-Step	Score 0	2	2	4	6.7
	Score 1	10	16	26	43.3
	Score 2	16	14	30	50.0
	Total	28	32	60	
Total	Score 0	5	8	13	10.8
	Score 1	20	31	51	42.5
	Score 2	31	25	56	46.7
	Total	56	64	120	

The step-by-step education protocol and traditional education protocol were statistically similar for the color transition parameter *(p=0.279).*

Table 7. The frequency of the scores for the evaluation parameter of finishing/polishing.

		Finishing/Polishing			
Education Protocol	**Scoring**	**Female**	**Male**	**Total Count (n)**	**Percent (%)**
Traditional	Score 0	3	9	12	20.0
	Score 1	24	22	46	76.7
	Score 2	1	1	2	3.3
	Total	28	32	60	
Step-by-Step	Score 0	0	2	2	3.3
	Score 1	18	19	37	61.7
	Score 2	10	11	21	35.0
	Total	28	32	60	
Total	Score 0	3	11	14	11.7
	Score 1	42	41	83	69.2
	Score 2	11	12	23	19.2
	Total	56	64	120	

The step-by-step education protocol was significantly different from the traditional education protocol for the finishing/polishing parameter *(p<0.001).*

Statistical Analysis

The independent investigator delivered Data Form 1 immediately before the statistical analysis. After combining Data Form 1 with Data Form 2, the related data were entered into the IBM SPSS Statistics V20 (SPSS Inc., Chicago, IL, USA). The quality of the restorations performed by the students under both educational protocols was compared in terms of the individual scores of each evaluation parameter and the total score. Data were statistically analyzed with the Mann-Whitney U test at a significance level of $\alpha<0.05$.

RESULTS

The total scores and individual scores for each parameter of the restorations performed by the students under both educational protocols were compared. Tables 2-7 demonstrate the frequency and percentage of the scores for the evaluation parameters of palatal and labial morphology, marginal adaptation, void formation, color transition, and finishing/polishing.

The step-by-step education group produced statistically higher scores in palatal morphology ($p<0.001$), labial morphology ($p<0.001$), marginal adaptation ($p=0.043$), and finishing/polishing ($p<0.001$)

parameters than the traditional education group. There was no significant difference between both educational groups regarding the void formation (p=0.058) and color transition (p=0.279) parameters.

Considering the total scores of the restorations performed under two different educational protocols, it was observed that the step-by-step education group produced statistically significantly higher scores than the traditional education group (p<0.001).

DISCUSSION

Mastering the skill of direct composite resin restoration for anterior tooth fractures is valuable for developing the knowledge and manual skills necessary to specialize in aesthetic dentistry. In the restorative dentistry curriculum, second-year preclinical students learn the fundamentals of direct Class IV composite resin restoration using a mono-shade composite resin with a freehand technique on artificial teeth. Third-year preclinical students advance to Class IV composite resin restoration using multi-shade composite layering with the silicone index technique on extracted natural human teeth.

To ensure consistent substrate conditions in this study, artificial teeth with standard tooth shade, shape, and size were used instead of extracted human teeth. The color transition parameter indirectly indicated students' ability to prepare optimal margin beveling and perform the incremental technique using various composite resin materials with different shades and opacities. The void formation parameter often correlates with insufficient manual skills or unfamiliarity with restorative materials. Students in both groups performed similarly in color transition and void formation, possibly due to their prior experience with margin beveling or familiarity with restorative materials gained in their second-year preclinical courses.

Given that the students in this study had no prior experience with the silicone index technique, their performance in restoration steps performed directly on the silicone index is more indicative when comparing the effectiveness of both educational methods. Precisely, students encountered novel techniques within the scope of this study, including reconstructing the palatal wall, approximal contours, and incisal edges on the silicone index.

In the silicone index technique, the quality of silicone indexes directly influences the palatal surface morphology of Class IV composite restorations. However, in this study, the instructor created and standardized the silicone indexes and fractured artificial teeth, and an unbiased, blinded researcher verified their quality before providing them to the students. Therefore, the differences in palatal morphology stemmed from the students' skill performance rather than variations in the silicone index quality.

The step-by-step education group demonstrated superior performance in palatal and labial morphology, marginal adaptation, and finishing/polishing of the restoration compared to the traditional group. Additionally, considering the total performance of restorations completed under both educational protocols, the step-by-step education group significantly outperformed their peers in the traditional education group. Several aspects and advantages of the step-by-step education method may account for this result.

Students may find it challenging to remember and focus on a complex task with all its intricacies. The step-by-step method addresses this by dividing a large, complex, multistep task into smaller, simpler segments. This approach narrows the scope of each task and reduces the number of technical details to be recalled. Students' ability to easily recognize the details of each task also strengthens their self-confidence. Furthermore, this method allows for continuous monitoring by the instructor or the student at each stage. This encourages students to seek guidance from the instructor to address specific difficulties encountered during a particular step, preventing errors from growing into irreversible issues in the final restoration. In addition, the step-by-step method creates an interactive learning environment, thus enabling the students to receive immediate and instructive feedback.

Research on teaching methodologies suggests that the step-by-step education method surpasses teacher-centered and student-centered approaches in effectiveness. While limited research exists on the impact of the step-by-step method on students' technical skills in procedures like crown preparation [11, 12], Class IV fracture restoration [9], or wisdom tooth extraction[13], existing studies indicate its benefits. For instance, Liu et al. (2019) demonstrated that the step-by-step method significantly improved preclinical students' skill performance compared to traditional approaches, regardless of whether assessments were conducted by students, instructors, or digital systems[12]. Yuan et al. (2020) similarly found that students learning with the step-by-step method achieved higher restoration quality in less time than those in an all-in-one learning environment [9]. Further supporting this, Yang et al. (2024) reported that the step-by-step teaching method enhanced dental students' clinical skills and satisfaction during impacted wisdom tooth extraction training, compared to the traditional all-in-one method[13]. Researchers attribute these improvements to the step-by-step method's ability to motivate goal-directed behavior, facilitate learning, and increase performance in dental skills education [9, 11-13]. Lukas et al. (2019) observed that students responded more favorably to the step-by-step approach than to traditional education[11]. Consistent with these findings, we observed greater engagement, enthusiasm, and interest among students in the step-by-step group, although these observations were not reflected in the study's statistical data.

Our findings are consistent with prior research evaluating the impact of the step-by-step education approach on students' technical skills and success in Class IV fracture restoration, crown preparation, and wisdom tooth extraction. We observed that preclinical students trained with the step-by-step education protocol achieved more successful restorations than their peers who received traditional education. Consequently, we rejected the null hypothesis, which stated that there would be no difference in student performance between the two different educational protocols for Class IV direct composite resin restoration skill practice.

To contextualize these findings, it is important to acknowledge several limitations of the present study. Although the use of artificial teeth allowed for standardization of substrate conditions, it does not fully replicate the optical and morphological characteristics of natural dentition, which may limit the clinical generalizability of the results. The evaluation was confined to short-term preclinical performance without assessing long-term outcomes or skill retention. Additionally, participants were recruited from a single institution, and individual differences in baseline manual skills were not objectively assessed, which may have influenced the results despite randomization. While the silicone indexes were standardized and prepared by the instructor to minimize variability, this process may not reflect real-world conditions in which students fabricate their own indexes. The absence of interobserver agreement analysis due to consensus-based evaluation may also introduce potential assessment bias. Furthermore, only one brand of composite resin materials was used, and results may vary with different material systems. Lastly, although students in the step-by-step group appeared more engaged and confident during training, these observations were not quantitatively evaluated using validated instruments.

Despite these limitations, this study's overall outcomes highlight the potential of the step-by-step education method as an effective and practical teaching strategy in preclinical dental education. By dividing complex procedures into manageable segments and providing continuous feedback, this method not only enhances technical performance but may also improve students' engagement and confidence.

In conclusion, the step-by-step educational approach represents an innovative, interactive instructor-student model that could complement and strengthen traditional methods in the dental education system. Future studies involving clinical settings, long-term follow-up, and multi-institutional samples are warranted to further validate its effectiveness and broaden its applicability.

REFERENCES

1. Velayo BC, Stark PC, Eisen SE, Kugel G. Using dental students' preclinical performance as an indicator of clinical success. J Dent Educ. 2014;78(6):823-828.
2. Fayaz A, Mazahery A, Hosseinzadeh M, Yazdanpanah S. Video-based learning versus traditional method for preclinical course of complete denture fabrication. J Dent (Tehran). 2015;16(1):21-27.
3. Rossettini G, Rondoni A, Palese A, et al. Effective teaching of manual skills to physiotherapy students: a randomised clinical trial. Med Educ. 2017;51(8):826-838. doi:10.1111/medu.13329
4. Palocaren J, Pillai LS, C TM. Medical biochemistry: Is it time to change the teaching style? Natl Med J India. 2016;29(3):166-168.
5. Habib S. Rubric system for evaluation of crown preparation performed by dental students. Eur J Dent Educ. 2018;22(4):e506-e513. doi:10.1111/eje.12357
6. Field JC, Walmsley A, Paganelli C, et al. The graduating European dentist: contemporaneous methods of teaching, learning and assessment in dental undergraduate education. Eur J Dent Educ. 2017;21(Suppl 1):28-35. doi:10.1111/eje.12324
7. Gottlieb R, Baechle MA, Janus C, Lanning SK. Predicting performance in technical preclinical dental courses using advanced simulation. J Dent Educ. 2017;81(1):101-109. doi:10.21815/jde.016.007
8. Ganyaupfu EM. Teaching methods and students' academic performance. Int J Humanit Soc Sci Invention. 2013;2(9):29-35.
9. Yuan JX, Yang KY, Ma J, et al. Step-by-step teaching method: improving learning outcomes of undergraduate dental students in layering techniques for direct composite resin restorations. BMC Med Educ. 2020;20(1):228. doi:10.1186/s12909-020-02135-2
10. Bohaty BS, Redford GJ, Gadbury-Amyot CC. Flipping the classroom: assessment of strategies to promote student-centered, self-directed learning in a dental school course in pediatric dentistry. J Dent Educ. 2016;80(11):1319-1327.
11. Lukas RW, Hardy SF, Johnson GM, Brownstein SA. Prep-along facilitated posterior crown preparation in the preclinical dental setting: a multimedia approach. MedEdPORTAL. 2019;15:10855. doi:10.15766/mep_2374-8265.10855
12. 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(4):344-348. doi:10.1111/eje.12441
13. Yang X, Yan T, Bao Z, Ouyang K, Huang L. Wisdom tooth extraction training for dental students: step-by-step or all-in-one? Br J Oral Maxillofac Surg. 2024;85:1-15. doi:10.1016/j.bjoms.2023.11.020.