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Step-by-step teaching method improves the learner achievement in dental skill training

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Abstract

Introduction: This study aimed to assess and compare the outcomes of all-in-one and step-by-step teaching methods in dental skill training.

Methods: Forty first-year dental residents were recruited into this study, which was a prospective, double-blind and randomised controlled trial. The learners were randomly allocated to either the all-in-one group (control group, n = 20) or the step-by-step group (experimental group, n = 20). They performed crown preparation on a plastic tooth under different training course structures. For the all-in-one group, the course comprised three parts: the teacher's lecture and demonstration and the learner's practice. Every part was carried out independently in turn. For the step-by-step group, the course was divided into six parts according to the procedures of crown preparation: incisal preparation, facial preparation, interproximal preparation, lingual preparation, marginal preparation, and finishing and polishing. Every part, consisting of the teacher's lecture and demonstration and the learner's practice, was carried out step-by-step. Thereafter, the training outcome was evaluated by the learners, two experts and a digital system.

Results: For the outcomes of the all-in-one group and the step-by-step group, the learners' assessments were 6.15 ± 1.98 and 8.10 ± 1.41, the experts' assessments were 7.00 ± 1.75 and 8.40 ± 1.10, and the digital assessments were 6.43 ± 1.20 and 7.62 ± 0.51, respectively. In terms of each evaluation index, there was significant difference between the two groups ($P < 0.05$). Higher quality of crown preparation was attained in the step-by-step group.

Conclusion: The step-by-step teaching method can improve the learner's achievement in dental skill training.

KEYWORDS

dental education, step-by-step, teaching methods, tooth preparation

1 | INTRODUCTION

Dentistry is a very practical discipline. The dental education determines, to a large extent, the quality of treatment in the dental practice.[1] The manual-skills training course occupies a very important position in the dental education system; however, the manual-skills training is always challenging for teachers because they have to start teaching the techniques right from the basics until the students master the required exercises.[2] In terms of prosthetic dentistry, crown preparation is a very fundamental practical skill that is essential for the development of basic knowledge and manual skills required for mastering fixed prosthodontics. Hence, crown preparation is a core part of university education and continuing education in prosthodontics.

A successful education system should enable the teacher to address the learner's demands and understand multiple teaching methods.[3] Over the years, the effectiveness of teaching methods has consistently raised considerable interest in education,[4,5] and since the mid-1990s, there has been a call for change in the way dental education is provided.[6] To facilitate the transmission of knowledge and skills, teachers should apply appropriate teaching methods that produce best outcomes, so traditional teaching methods in dentistry, lecture and practice, are being augmented with innovative teaching methods.[7]

For prosthodontics, the previous curriculum of crown preparation comprised the teacher's theoretical lecture and/or practical demonstration followed by the learner's skill practice in artificial teeth. However, we often observed some limitations within this teaching method. The procedures of crown preparation for anterior teeth consisted of six parts[8,9]: incisal preparation, facial preparation, interproximal preparation, lingual preparation, marginal preparation, and finishing and polishing. Different reductions, techniques and instruments are needed in each step, which were complex for inexperienced practitioners. Consequently, the final preparation might not be excellent without proper teaching methods. At the Department for Continuing Education of the Chinese Stomatological Association, we have practiced a step-by-step approach in dental skill training since 2013. In our experience, learners perceived their learning to be facilitated better by step-by-step instruction, and this teaching method might improve their achievement in crown preparation.

This study aimed to assess and compare the outcomes of this new teaching method, the step-by-step approach, and traditional teaching method, the all-in-one approach, in crown preparation. The null hypothesis is that there is no difference between the learners' achievement from the two teaching methods. The study is potentially useful for the development of a new, reliable approach for the dental skill training course.

2 | MATERIALS AND METHODS

A total number of 40 first-year dental residents from 23 dental institutions participated in this study. It was a prospective, double-blind and randomised controlled trial. The research hypothesis was concealed, and the teachers and learners were blinded to the precise purpose of the study to counterbalance the lack of direct blinding. The learners were randomly allocated to either the all-in-one group (control group, n = 20) or the step-by-step group (experimental group, n = 20), using the envelope method. During this training, the learners performed all-ceramic crown preparation on a plastic, upper-left, central incisor mounted on an artificial dental model (DSE, Kavo, Biberach an der Riss, Germany) under different education protocols (Figure 1).

The training focused on the procedures as well as the techniques and instruments used for performing crown preparation. The course contents were the same in the two groups, but the curriculum structures were different. For the all-in-one group, after a teacher's 18-minute theoretical lecture and 12-minute practical demonstration outline of the main knowledge and skill requirements of crown preparation, a 30-minute learner's practice followed. Each of the three parts was carried out as a whole in turn. The total time allowed for the course was 60 minutes. For the step-by-step group, the 1-hour course was divided into six parts according to the procedures of crown preparation: incisal preparation, facial preparation, interproximal preparation, lingual preparation, marginal preparation,

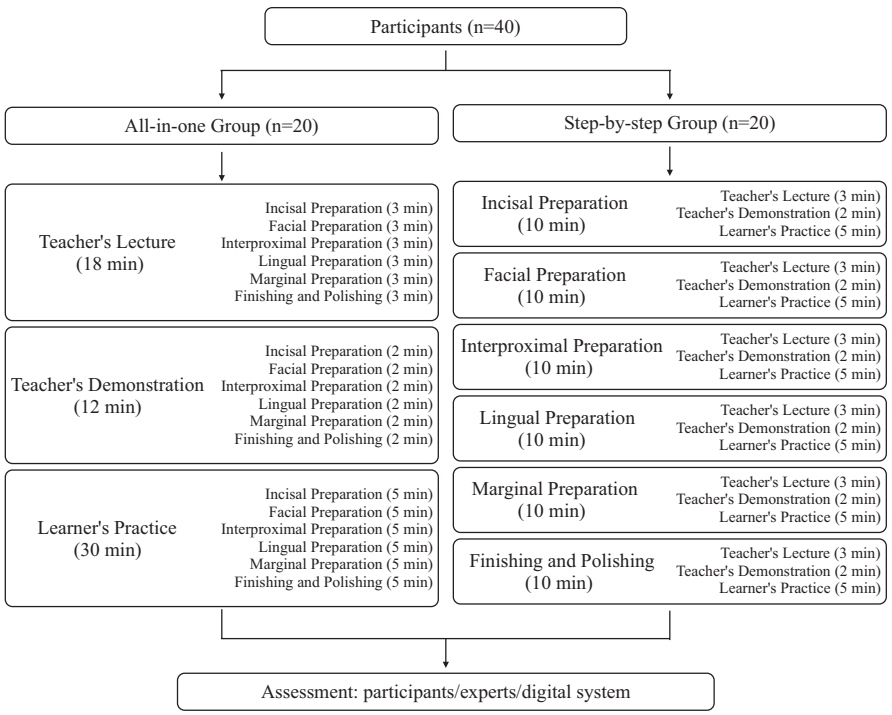

FIGURE 1 Structure of the courses of the all-in-one group and step-by-step group

TABLE 1 Parameters followed in all-ceramic crown preparation

	Grades			
Parameter	**1.5 points**	**1.0 point**	**0.5 point**	**0 point**
Incisal reduction	Optimal reduction (2.0-2.5 mm)	Moderately under-reduced (<2.0 mm)	Moderately over-reduced (>2.5 mm)	Severely over-reduced or under-reduced (>3.0 or < 1.5 mm)
Axial reduction	Optimal reduction (1.2-1.5 mm) and rounded line and point angles	Moderately under-reduced (<1.2 mm) or lack of rounded line or point angles	Moderately over-reduced (>1.5 mm)	Severely over-reduced or under-reduced (>2.0 mm or < 1.0 mm)
Taper	Optimal taper (retentive walls have 6° of taper)	Under- or over-taper (Taper present, but near parallel or over-tapered on mesial or distal, >8° and < 16°)	Moderately under- or over-tapered (undercuts visually present or over-tapered on labial or lingual, >8° and <16°)	Severe under- or over-taper (severe undercuts present or severe over-tapered on any axial surface, >16°)
Margin placement	Optimal margin placement (Even with free gingival margin or <0.5 mm supragingival)	Over- or under-extended (<0.5 mm subgingival or <1.0 mm supragingival)	Moderately under- or over-extended (<1.0 mm subgingival or <1.5 mm supragingival)	Severely under- or over-extended (>1.0 mm subgingival or >1.5 mm supragingival)
Two-plane reduction	-	Proper planes (providing adequate material bulk for strength/aesthetics)	Moderately improper planes (over-reduced or under-reduced)	Significantly improper planes (over-reduced or under-reduced)
Finish, margins and walls	-	Optimal finish (margins and walls are smooth, continuous and well-defined)	Moderate roughness (moderate roughness of margins and walls, or margins are moderately non-continuous, or moderate lack of definition)	Significant roughness (significant roughness of margins and walls, or margins are non-continuous or lack of definition of finish line)
Preservation of adjacent teeth	-	Adjacent teeth are unaffected	Adjacent teeth are minimally touched	Adjacent teeth are abraded and flattened
Time management	-	Ends on time	Ends <10 min late	Ends >10 min late

and finishing and polishing. Each part, consisting of the teacher's 3-minute theoretical lecture, a 2-minute practical demonstration, and learner's 5-minute practice, was carried out step-by-step. The total time allowed in this group was same as in the control group.

After completion of the course, the teaching effect was evaluated by the learners, using a visual analogue score (VAS). The result was represented by 11 numbers from 0 to 10. The lower the score, the less ideal the outcome was. The higher the score, the better the outcome was. In addition, the quality of tooth preparations was assessed by two experts and a digital system, with an analytic rubric for assessment of various tooth preparation parameters (Table 1). The learners' groups were kept confidential from the raters. The two experts, who were unaware of the group the learner attended, evaluated the quality of preparations separately without time limitation. For the digital assessment, the quality of preparations was evaluated by a dental education training system (Aizhixing, Dcarer, Jiangsu, China).

The analytic rubric (Table 1) used was modified from a previous study.[6] It was based on a 10-point scale for assessment of eight parameters of all-ceramic crown preparation. The scoring of each major parameter, such as incisal reduction, axial reduction, taper and margin placement, was further subdivided into 1.5, 1.0, 0.5 and 0 points. The rest of the four parameters (two-plane reduction, finishing of walls and margin, preservation of adjacent teeth and soft tissue, and time management) were supposed to get a score of 1.0, 0.5 or 0.

Measurement data are expressed as mean ± standard deviation. Data were analysed through SPSS Statistics, version 20.0 (IBM Corp., Armonk, NY) using independent samples *t* test. The significance level was set at 0.05.

3 | RESULTS

The outcomes of the all-in-one and step-by-step teaching methods in crown preparation were analysed in this study. The main characteristics of the 40 learners were homogeneous at baseline, as shown in Table 2. There was no significant difference between the two groups.

The VAS of teaching effect evaluated by learners, the quality of preparations evaluated by the experts and the quality of preparations evaluated by the digital system for the all-in-one group and the step-by-step group were 6.15 ± 1.98 and 8.10 ± 1.41 (P = .001), 7.00 ± 1.75 and 8.40 ± 1.10 (P = .005), and 6.43 ± 1.20 and

TABLE 2 Main characteristics of the 40 learners

Characteristic	Group	
	All-in-one	Step-by-step
Number (n)	20	20
Gender		
Female (n)	13	11
Male (n)	7	9
Age (y)	25.7 ± 2.2	25.9 ± 2.1
Qualification		
Dental degree (n)	14	15
Master/Doctor (n)	6	5
Specialty		
Non-Prosthodontics (n)	15	16
Prosthodontics (n)	5	4

7.62 ± 0.51 ($P < .001$), respectively (Table 3). In terms of each evaluation index, the independent samples *t* test indicated significance between the control group and the experimental group. For the purpose of this study, which was to assess and compare the outcomes of all-in-one and step-by-step teaching methods in crown preparation, it was observed that better learner achievement was attained in the experimental group.

4 | DISCUSSION

This research study's aim was to determine the impact of teaching methods on learners' performance in dental skill training, in this case, in crown preparation. As such, the study tested the null hypothesis that there is no difference between learners' achievement by the all-in-one teaching method and by the step-by-step teaching method. The results indicated that the step-by-step teaching method produced better outcomes in crown preparation. Therefore, the null hypothesis was rejected.

The primary purpose of teaching is to bring fundamental changes to the learner. There is now a greater need to understand the various processes that underpin both the ways in which the curriculum is delivered and the ways in which the learner engages with learning.[7] Lectures and illustrated textbooks may be useful elements in dental education, but they cannot replace direct contact and touch.[10]

TABLE 3 Learners' achievement in the all-in-one group and step-by-step group

Group	Assessment		
	Learners	Experts	Digital system
All-in-one	6.15 ± 1.98[a]	7.00 ± 1.75[a]	6.43 ± 1.20[a]
Step-by-step	8.10 ± 1.41[b]	8.40 ± 1.10[b]	7.62 ± 0.51[b]
Significance	0.001	0.005	0.000

For each column, groups identified by different superscript letters (a, b) were significantly different ($P < 0.05$).

Learners are always appreciative of a hands-on course, and they experience a considerable progress in skills. They acquire an intimate skill for crown preparation through listening to the lecture, observation of the demonstration and hands-on practice. This multifaceted activity with involvement of many senses facilitates learning.[11,12] However, in our experience, the inexperienced learners' achievement in anterior crown preparation was not ideal from the traditional all-in-one teaching approach. The pessimistic result might be attributed to the learners' unfamiliarity with the complex steps of tooth preparation, including the details of reductions, techniques and instruments. The cumulative effect of minor errors in each step will lead to greater errors in the final result. The initial purpose of step-by-step teaching methods is to refine the skill of crown preparation into steps as detailed as possible. The present study demonstrated that the new curriculum design and teaching method improves the final result on the basis of amelioration of the training at each step.

As we have known, a significant manifestation of dental treatment involves precise eye-hand coordination, so a large portion of dental education is devoted to the acquisition of these skills.[13,14] In addition to traditional lectures supported by slides, blended teaching techniques cater to multiple learning styles and have been shown to provide better outcomes.[15,16] As technology advances, simulations are being developed to support the acquisition of skills before real-life clinical applications.[17] However, it is not always possible for a teacher to explain how everything is carried out, even if they themselves have mastered the skill.[7] Therefore, besides the theoretical lectures, it is also important to allow the learners to observe practice being performed by qualified, experienced and competent teachers.[7] Careful observations and reflection can reveal a whole new experience for the learner.[18] In the present study, step-by-step demonstration and tacit learning were shown to stimulate the learners' interest effectively and offered ample opportunities to integrate theoretical and practical understanding, thus enhancing the learning outcome.

In the traditional epoch, teachers widely applied teacher-centred methods in the curriculum. Because the teacher controls the transmission and sharing of knowledge and skills, this approach is more theoretical and memorised but least practical.[19] Thereafter, scholars specified that teaching should not merely focus on dispensing theoretical knowledge for learners to memorise but should, also, actively encourage them to participate, which is the student-centred approach, to enhance active learning.[20] This teaching method motivates goal-oriented behaviour amongst students, hence is effective in improving learner achievement.[21] The present step-by-step teaching method applies the strategies both teacher-centred and student-centred approaches use, that is, the teacher-student interactive method.[19] Research evidence on teaching approaches maintains that this method is more effective than the teacher-centred and student-centred approach.[19] In the present study, it proved to be more effective for the learners to be tasked with practicing in a detailed, step-by-step manner rather than just being asked to mixed all procedures together. By breaking down the task, the teacher created an atmosphere conducive to learning to enhance the development of the learner's manual skills. The step-by-step approach

provides an arena for close and positive interaction between learners and teachers, thereby nurturing a good educational environment that has important and positive implications for learners. As a result, they perform better in hands-on ability when they are engaged to achieve the final goal step-by-step during class activities.

The limitation of the current study is that it was conducted by one dental technique, which was crown preparation, and the evaluations were carried out immediately without a long-time follow-up, so the results cannot be generalised. Thus, the study should be interpreted with caution. Future research, with various dental techniques, larger sample sizes and a long follow-up, is necessary before promoting the widespread use of this step-by-step teaching method for dental skills training.

5 | CONCLUSION

Within the limitations of this study, the results suggest that the outcome of the step-by-step teaching method was better than that of the all-in-one teaching method. Therefore, the step-by-step teaching method is effective for improving the learner achievement in dental skills training, as documented by the test results and as experienced from the teachers' and learners' attitudes and interactions.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

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