Original Article

The impact of team teaching on cephalometric tracing education among dental students: A quasi-experimental study

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Abstract

Background & Objective: Cephalometric tracing education in orthodontics necessitates a thorough review of human anatomy. Juggling expertise in two fields poses a challenge for professors. A collaborative solution, such as the team teaching model where two professors jointly instruct students, was explored in this study to investigate its impact on teaching cephalometric tracing to dental students in Zanjan during 2021-2022.

Materials & Methods: This quasi-experimental study involved the participation of all 67 dental students across two semesters in 2021 and 2022. In a shared classroom setting, the orthodontist traced the cephalogram image on the whiteboard, and immediately the radiologist described the related bones using software. This interactive teaching approach persisted throughout the class. At the conclusion of each session, students were given a teaching satisfaction form and a researcher-developed questionnaire containing anatomy questions. Descriptive statistics, including frequency and percentage, were employed, and a Paired T-test was conducted for analytical statistics (p-value = 0.05).

Results: The overall satisfaction percentage of students was 79.75% (563 of 706 response).The highest level of satisfaction was related to the satisfaction with the teaching method. The highest level of dissatisfaction was related to saving time. A comparison of the mean scores of the pretest and posttest showed no significant increase in learning.

Conclusion: Student satisfaction with team teaching is notably high, particularly in relation to the teaching method. However, challenges related to time efficiency were identified as a drawback of this teaching model. Taking into account the study's limitations, it was concluded that team teaching did not significantly impact the learning rate.

Keywords: teacher, orthodontics, educational models, team-teaching, dental care

Introduction

In orthodontics, diagnostic records play a crucial role in completing clinic examinations. Among these records, cephalometric radiographs serve as an anatomical foundation for studying maxillofacial proportions. Cephalometric analyses commence with the tracing and identification of precise locations of anatomical landmarks on a cephalogram (1, 2). Dental students familiarize themselves with cephalometric radiographs and relevant landmarks during theoretical radiology courses, further advancing their understanding in theoretical orthodontic courses. Both these courses constitute specialized components presented after basic sciences courses. During anatomy science courses, which are integral to basic sciences, students delve into the intricacies of skull anatomy. However, the sheer volume of information learned during basic sciences, particularly in anatomy courses, may fade from memory within weeks (4, 5). Consequently, reviewing human anatomy becomes imperative for students during tracing classes. Additionally, students need to revisit the preparation of cephalograms and recall common errors in interpreting them. Thus, teaching or receiving principles of radiology is essential in orthodontic courses.

Presently, medical and dental schools are compartmentalized into different departments, each independently providing education for respective fields and courses (6, 7). The challenge arises when a university

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professor is tasked with expertise in two different fields simultaneously. The collaborative remedy for this issue is teamwork among professors from diverse fields (8). The co-teaching approach involves instructors (usually two individuals) jointly planning, implementing, and evaluating a course. Each instructor assumes relevant responsibilities based on their joint activity. This approach encompasses various models, such as one instructor/one observer, one instructor/one assistant, parallel, station, alternative, and team teaching (9-11). The team teaching model involves two professors, with complementary specialties and equal responsibility, taking turns lecturing in a shared classroom to educate students collectively (12, 13). Team teaching offers several advantages, including each professor specializing in their mastered subject, heightened student motivation due to teaching method variety, students creating a model by observing professor collaboration, increased sympathy and cooperation between professors, enhanced familiarity with new educational approaches, and more leisure time for professors due to reduced educational material volume (14). A quasi-experimental study by Satayev et al. (2022) concluded that the team teaching approach significantly outperformed conventional teaching in achieving educational goals for teaching English and biology (15). McDonald et al. (2020) reported the advantages of team-taught practical anatomy lessons over the solo-taught model, improving students' final scores (16). Peiman et al. (2017) successfully employed the team teaching approach to integrate basic and clinical sciences at Tehran University of Medical Sciences, receiving positive feedback from students (17).

Notably, our search revealed that the team teaching approach has not been implemented for educational purposes in dentistry in Iran. Consequently, this study evaluated the impact of team teaching on student satisfaction and its effectiveness in cephalometric tracing education for dental students at the Faculty of Dentistry, Zanjan University of Medical Sciences, Zanjan, Iran, during the academic years 2021-2022.

Materials & Methods

Design and setting(s)

This quasi-experimental study spanned two semesters in 2021 and 2022.

Participants and sampling

The target population comprised all 67 dental students enrolled in the second theoretical orthodontics course during these two semesters.

Tools/Instruments

The standard form assessing satisfaction with the teaching method consisted of 16 items. The validity of this questionnaire was confirmed by professors and specialists in the field in a study by Borim Nejad et al. (2014). Additionally, the reliability, as measured by Cronbach's alpha coefficient, exceeded 0.70 in the same study (18). Following modifications and revisions, eliminating statements irrelevant to orthodontic lessons, the questionnaire retained 12 statements. Each statement offered three response choices: never (score 1), to some extent (score 2), and completely (score 3).

Data collection methods

A few days before the scheduled class, the responsible researcher, an orthodontist, conducted a session with a collaborating colleague from the Department of Radiology. This aimed to assess audiovisual facilities, equipment, and the necessary physical environment for implementing the research plan. Once the feasibility of the plan was confirmed, the two colleagues collaboratively designed a lesson plan during joint sessions, determining lecture times and responsibilities. These planning meetings involved discussions on teaching methods, addressing contradictions between the two fields, and refining the teaching approach.

Given the essential requirement for a comprehensive understanding of anatomy in three dimensions and its radiological appearance, virtual education and software educational models became pivotal. The Ess. Skeleton 4 software, selected for its practicality, can display all human body bones in three dimensions. Notably, this software allows the separation of each bone from adjacent ones, presenting them individually or involving transparency to visualize sutures and bony attachments three-dimensionally at a close range. The Ess. Skeleton 4 software, known for its user-friendly interface and superior views of the human skeleton, was employed in this study.

On the scheduled day and time designated by the Educational Office of the Faculty, the orthodontist initiated the lecture and tracing in the classroom. The radiographic image of the skull on cephalograms was displayed via a video projector onto a clean whiteboard. Simultaneously, the radiologist employed the Ess. Skeleton 4 software using a second video projector,

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projecting the desktop computer monitor onto the screen. The radiologist explained how the lines on the cephalogram corresponded to the relevant anatomical structure. Professors, specializing in different fields, took turns delivering lectures in collaboration, ensuring that the second lecturer provided necessary information when the subject matter required insights from other specialty fields. This collaborative teaching approach continued throughout the entire class. Professors engaged in interactions with students, encouraging questions, and providing relevant responses within their respective fields.

At the conclusion of the class, students were handed a modified satisfaction questionnaire, prompting them to respond to the questions. Additionally, a researcher-made questionnaire, comprising 5 questions with 4 choices for each question on head and face anatomy, was distributed among the students as a pretest, collected after 5 minutes, and then followed by a posttest after 2 weeks. As the students were not acquainted with cephalometric tracing before the class, all questions on the questionnaire pertained to the anatomy of the head and neck region.

Data analysis

Data were entered into SPSS-24 software for analysis. Descriptive statistics, including frequency and percentage, were employed for summarizing the data. Analytical statistics utilized the Paired T-test, with a significance level set at 0.05. This statistical analysis aimed to explore any significant differences and trends in the collected data, providing insights into the impact of team teaching on dental students' cephalometric tracing proficiency.

Results

The students completed fifty-nine satisfaction questionnaires during these two terms (Table 1). The participation rate in completing the questionnaire in the first term was 13%, primarily due to the COVID-19 pandemic. This rate increased to 75% in the subsequent term, reflecting improvements in acute pandemic conditions (Figure 1).

Table 1. Demographic information of participants who completed the satisfaction questionnaire

Gender \ Year	2021	2022	Total
Female	4	32	36
Male	3	20	23
Total	7	52	59

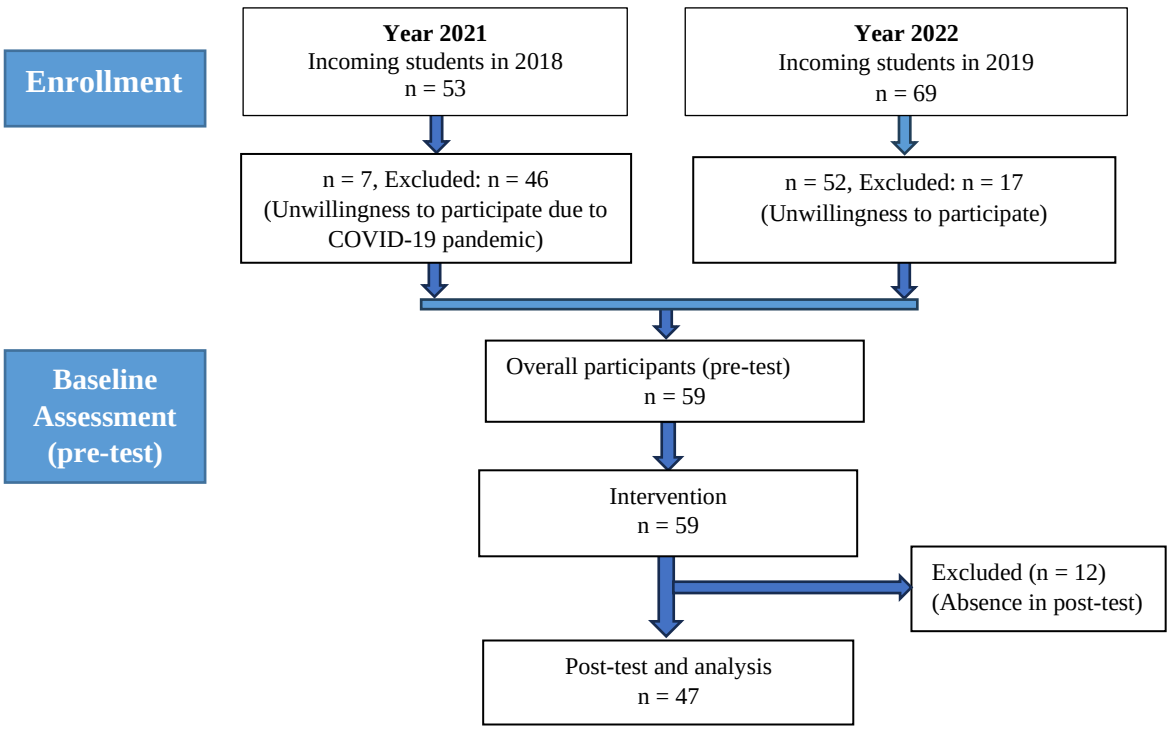


Figure 1. The process of study

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In the satisfaction section, the overall satisfaction of students with this teaching method was 79.75% (563 of 706 response). The highest percentage (91.5%) of satisfaction among the items (54 of 59) belonged to the item "I am generally satisfied with this method". The highest percentage (6.8%) of dissatisfaction was related to the item (4 of 59) "learning with this method occurs in a shorter time" (Table 2).

Table 2. Modified questionnaire for use in teaching the subject of tracing of cephalometry and the frequency (percentage) of satisfaction with the teaching method

No	Object[$]	Completely (Score 3)	Tosome extent (Score 2)	Never (Score 1)	Total response
1	I liked this teaching method	53 (89.8%)	6 (10.2%)	0 (0.0%)	59 (100%)
2	My information needs were better answered	46 (78.0%)	12 (20.3%)	1 (1.7%)	59 (100%)
3	The knowledge and skills I gained through this method are used in my career	46 (78.0%)	12 (20.3%)	1 (1.7%)	59 (100%)
4	With this method, I can get a better grade	40 (67.8%)	19 (32.2%)	0 (0.0%)	59 (100%)
5	Learning with this method occursin a shorter time	41 (69.5%)	14 (23.7%)	4 (6.8%)	59 (100%)
6	Learning is better in this way	52 (88.1%)	7 (11.9%)	0 (0.0%)	59 (100%)
7	In this way, my motivation to learn increases	51 (87.9%)	7 (12.1%)	0 (0.0%)	59 (100%)
8	With this method, my interest in orthodontics increased	43 (74.1%)	14 (24.1%)	1 (1.7%)	59 (100%)
9	With this method, I got to know the anomalies better	40 (67.8%)	17 (28.8%)	2 (3.4%)	59 (100%)
10	With this method, my skill in interpreting the cephalometry increased	48 (81.4%)	11 (18.6%)	0 (0.0%)	59 (100%)
11	I am generally satisfied with this method	54 (91.5%)	5 (8.5%)	0 (0.0%)	59 (100%)
12	I recommend implementing this method in other lessons	49 (83.1%)	10 (16.9%)	0 (0.0%)	59 (100%)
Total response		563 (79.75%)	134 (19%)	9 (1.25%)	706 (100%)

Note: [$]The Persian version of this questionnaire was used in this research

In the learning section, Students who were absent from the first (pretest) or the second session (posttest) were excluded from this section. Therefore, the total sample size in this section was 47 (Figure 1). A comparison of the mean scores of the pretest and posttest (4.55 and 4.74 of 5, respectively) showed no significant increase in learning ($p = 0.96$); however, the mean posttest score was slightly higher than that of the pretest (Table 3).

Table 3. Student's learning mean score out of 5

	n	Mean	Std. Deviation	p-value
Pretest	47	4.53	0.654	0.096
Posttest	47	4.74	0.488	

Note: A paired t-test was used to compare the pre-test and post-test scores.
Abbreviations: n, participants number; Std., standard; P, probability

Discussion

In this study, students expressed complete satisfaction with the team teaching approach. The highest level of satisfaction was observed in the statement "I am generally satisfied with this approach," indicating a positive reception of team teaching among students. A similar study at Tehran University by Peiman et al. (2017) reported a 78% satisfaction rate with this approach (17). Potter et al. (2021) found that 67% of students were highly to moderately satisfied, with only 23% expressing dissatisfaction (20). Team teaching involves a collaborative effort by professors to design and implement an educational program simultaneously, aiming to create a conducive learning environment that is effective, innovative, challenging, and lively (21).

The primary source of dissatisfaction was associated with the statement "learning with this method occurs in a shorter time." Roberts (1995), utilizing the team teaching approach in bilingual English instruction, argued that the repetition of material by an English teacher might be perceived as time-wasting by students, who expect to hear the material in their preferred language (22). Time emerged as a critical factor, encompassing the pre-implementation time required for professional development and the time consumed during implementation due to impromptu discussions. Successful implementation of team teaching necessitates intensive staff development, including understanding the rationale behind the approach, joint reading/studying, fostering positive collaboration, and learning effective time management skills to ensure seamless performance during sessions and in the classroom (23).

Although this study revealed no significant difference in learning, the mean scores of the posttest were slightly

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higher than the pretest scores. In contrast, Muza (2021) reported significantly higher scores in the experimental group compared to the control group when evaluating the impact of team teaching on the academic performance of undergraduate students in the Department of Pedagogy at the Nigerian Science and Technology University (24). Similarly, Satayev et al. (2022) found that the team teaching approach significantly improved academic performance in both biology and English language lessons (15). The limited improvement observed in this study might be attributed to the small number of questions (5) and their focus on human anatomy, which, while not directly related to cephalometric tracing, represents a potential limitation.

The challenges surrounding the team teaching approach are diverse and intricate. No single model guarantees success in a particular educational context. Each team educational program should be tailored to the lesson plan, instructors, and students (23). Educational strategies and collaborative schemes should be eclectic to align with learners' expectations and enhance their motivation for learning (25).

The limitations of this study encompass various aspects that should be considered in interpreting the findings. (a) The sample size of 67 dental students may be viewed as relatively small, limiting the generalizability of results beyond the specific context of the study. Additionally, the composition of the sample might not fully capture the diversity present in larger populations of dental students. (b) The study's context-specific nature, conducted in a particular dental school in Zanjan, Iran, raises concerns about the broader applicability of the results to dental schools with different structures, teaching methodologies, or student demographics. The uniqueness of the institutional and cultural setting could influence the outcomes and limit the study's external validity. (c) The assessment of learning outcomes using only five questions focused on human anatomy may not have provided a comprehensive understanding of the impact of team teaching on cephalometric tracing education. The brevity and specificity of the assessment tool may not have fully captured the complexity of the subject matter. (d) The study's relatively short timeframe, spanning two semesters, may not have allowed for a thorough exploration of the long-term effects of team teaching. Learning curves and adaptation to this teaching method may require an extended period to manifest fully. (e) The study instrument's focus on general satisfaction and specific aspects of the teaching method may have overlooked other elements influencing students' experiences with team teaching. A more comprehensive exploration of diverse aspects of the learning environment could have provided a richer understanding of the students' perspectives.(f) External factors, such as changes in the learning environment due to the COVID-19 pandemic, could have influenced students' experiences and satisfaction, introducing confounding variables that are challenging to control. (g) The study did not explicitly consider students' pre-existing knowledge or familiarity with cephalometric tracing, potentially overlooking variances in baseline knowledge that could impact individual learning outcomes.

Conclusion

In conclusion, our investigation into the impact of team teaching on cephalometric tracing education among dental students yielded valuable insights. The students demonstrated a high level of satisfaction with the team teaching approach, emphasizing its potential to create a positive and engaging learning environment. The collaborative efforts of professors in this approach were perceived favorably, aligning with findings from similar studies in different educational settings. However, the study revealed a notable concern regarding the perception of time efficiency, with students expressing dissatisfaction with the belief that learning through team teaching might occur in a shorter time. This sentiment resonates with the broader challenge of managing time within the team teaching framework, encompassing both pre-implementation professional development and in-class time utilization. Addressing this concern is crucial for optimizing the benefits of team teaching.

Interestingly, the examination of learning outcomes showed no significant improvement, suggesting that the team teaching approach, while well-received, may not inherently enhance academic performance in the context of cephalometric tracing. The limited number and focus of the questions, primarily on human anatomy rather than directly on cephalometric tracing, could be contributing factors. This underscores the importance of tailoring assessments to align closely with the specific educational objectives. The challenges identified, particularly those related to time and specific learning outcomes, emphasize the need for careful consideration and customization when implementing team teaching in dental education. While the approach offers a dynamic and collaborative pedagogical model, its success depends on effective management of these challenges. Future research could explore refined strategies within

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the team teaching framework, addressing identified limitations and optimizing the approach for cephalometric tracing education.

Overall, this study contributes valuable insights into the application of team teaching in dental education, shedding light on both its merits and challenges. As dental education continues to evolve, incorporating innovative and effective teaching methods becomes imperative, and the findings from this study provide a foundation for further exploration and refinement of team teaching practices in this specialized field.

Ethical considerations

The study was conducted with the approval of the National Agency for Strategic Research in Medical Education, Tehran, Iran (code: IR.NASRME.REC.1400.264). Participants were provided with comprehensive information regarding the study's objectives and methodologies, and their informed consent was obtained.

Artificial intelligence utilization for article writing

No.

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Conflict of interest statement

The authors declare no conflicts of interest, whether financial or non-financial.

Author contributions

All authors played pivotal roles in the conception and design of the study, as well as in the acquisition, analysis, and interpretation of data. Drafting and critical revision of the manuscript for important intellectual content were collaborative efforts involving all authors. Each author has read and approved the final manuscript, taking responsibility for all aspects of the work and committing to address any questions regarding the accuracy or integrity of the content.

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Data availability statement

The datasets utilized in this study are accessible from the corresponding author upon reasonable request.

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