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# A Review of Learning Styles in Orthodontic Education

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## ABSTRACT

Learning styles among students of orthodontics has received very little importance as seen in the limited studies found in the literature. The learning styles of students form an essential part of knowledge acceptance and delivery. The present study, therefore, has identified and reviewed the learning styles used in orthodontic education to understand the methods followed by orthodontic training programmes and their implications on learning. The objective of this study is to summarise the different types of learning styles currently utilised by the faculty of orthodontics. A systematic electronic search was conducted revealing eight studies used in orthodontic training. The searches conforming to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines used Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome (PICO) strategy for selecting the included studies. The number of studies included in this study was eight. The study analysed the different learning styles and their effects on knowledge and students' attitude. The availability of a small number of studies underscores the need to review the limited resource available to gain a better understanding of how orthodontic residents learn. This study on learning styles among orthodontic students provides a platform for building more knowledge on the learning pathways currently employed. The learning styles have an enormous influence on knowledge acquisition and retention. The study highlights the need for further exploration of the learning needs of orthodontic residents in an attempt to reveal potential benefits both for the student and the teaching faculty.

**Keywords:** *Learning styles, Orthodontic education, Dental education, Orthodontic learning*

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## INTRODUCTION

Professional dental education involves the integration of knowledge, skills, and values towards clinical competence. The clinical competence and the development of a new skill encompass various levels

of assimilating, understanding, retrieving and reflecting on acquired information (1). Learning in orthodontics occurs in a teacher-centric approach with students following the instructor's methods closely. The orthodontic training following an apprenticeship approach fails to identify

individual traits of students (2). This lack of understanding leads to skill development based on a collective ideology. The unique attributes of the individual student are compromised. The students in order to develop their skills based on individual needs use different tools to achieve the same level of competence as required for clinical duties and responsibilities (3). The individual learning styles create a challenge in framing appropriate methods to engage a wider audience. The difference in students learning styles may be associated with an inability to understand concepts and progress. The learning styles and its understanding might provide an insight into designing appropriate teaching systems with equal representation of all styles.

The learning styles as part of the learning process and educational approach in orthodontics have not been reviewed and thereby forms the basis of this study to perform an exploration into different learning styles used in orthodontic education. The study will assess acceptance and attitudes towards various learning styles utilised in orthodontic education in an attempt to understand if learning styles influence knowledge acquisition by students. The reviewed learning styles used previously by several other authors will also help gain an understanding of the outcomes and efficiency of these styles. Therefore, the aim of this study is to review and highlight the various learning styles available for orthodontic residents and their mentors and to understand their effect on skill enhancement amongst orthodontic residents.

## MATERIALS AND METHODS

An electronic search for articles in the English language was performed up to August 2018 on PubMed/Medline/EMBASE/WorldWideWeb using Google Scholar. The keywords used for the search included orthodontics and orthodontic education and orthodontic curriculum

and students learning styles and learning style assessment. The Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome (PICO) strategy was used for study inclusions. The participants included the dental undergraduate and orthodontic post-graduate students. The intervention included learning strategies employed. Comparison of different programmes was between e-learning strategies and conventional methods. The study outcomes assessed student attitudes. The search revealed a total of eight studies describing learning styles in orthodontic education. The studies will be analysed on the outcome and students' attitudes towards different learning styles.

**Inclusion criteria:** Only English language articles with learning styles or any form of learning strategy as an intervention in orthodontic education were chosen. Articles belonging to all types of study designs were included. Table 1 represents the search strategy used in identifying the studies for this review.

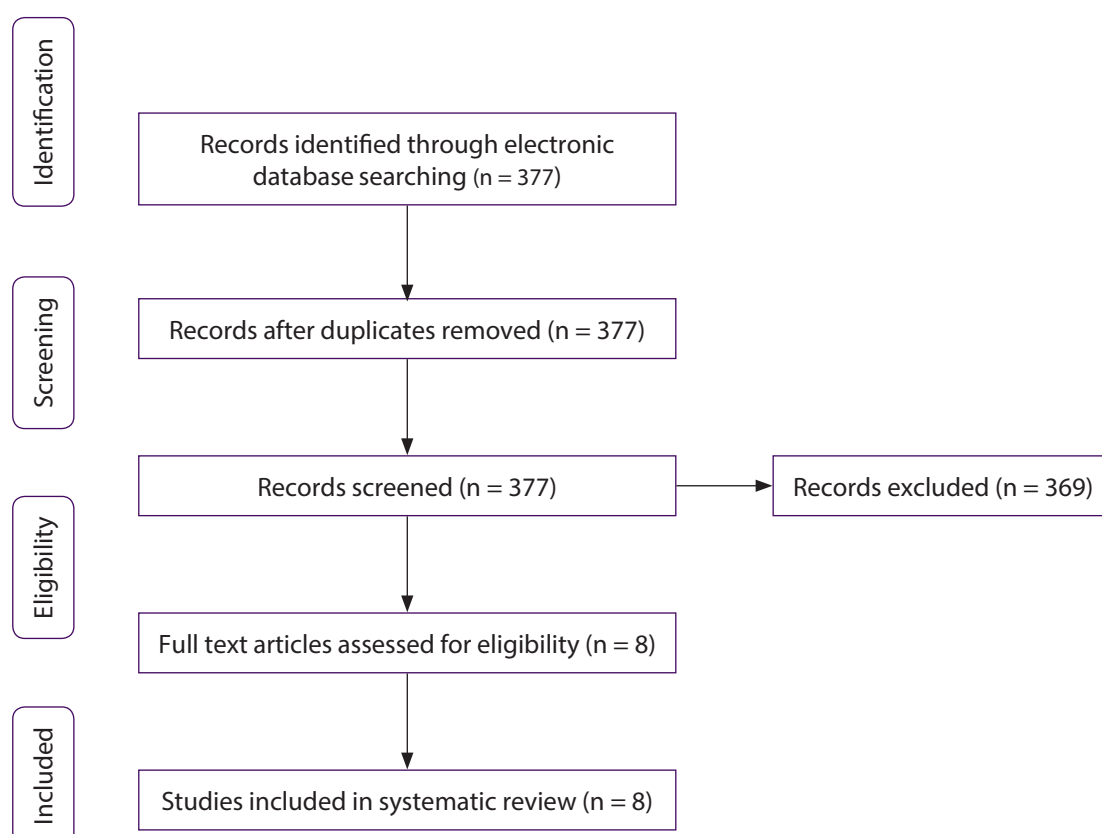
**Exclusion criteria:** Non-English language articles and non-orthodontic reviews were excluded.

The studies followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for study inclusions (4). A total of 377 records were identified. No duplicates were found, and 369 non-relevant articles were removed as they failed to match the inclusion criteria. Title and abstract matches revealed eight articles, which were later included for a full review as represented in Figure 1.

The article screening was initially performed by one reviewer. The screening eliminated non-orthodontic studies, studies without outcome measures of knowledge gain and students' attitudes and comparison groups. The selected studies were then assessed by a second reviewer to match the inclusion criteria set forth by the authors.

**Table 1:** Keywords employed in identifying the studies

Keywords	Number of sources found
Learning styles and orthodontics and orthodontic education	4080
Learning styles and learning style assessment in orthodontics and orthodontic education	909
Learning styles and learning style assessment in orthodontics and orthodontic education and orthodontic curriculum	425
Orthodontics and orthodontic education and orthodontic curriculum learning styles and learning style assessment	406
Orthodontics and orthodontic education and orthodontic curriculum and students learning styles and learning style assessment	377
Exclusion of non-orthodontic articles	362
Studies included at title stage	15
Studies included at abstract stage	11
Studies included for full review	8
Studies included in this study	8

**Figure 1:** PRISMA flow diagram representing the inclusion of studies.

## RESULTS

The learning styles in orthodontic education review analysed eight studies conducted up to August 2018 as represented in Appendix.

All the eight studies involved evaluation of learning styles employed in orthodontic education. The different learning styles were assessed for their outcome and students' attitudes. The learning styles reviewed include "Portfolios and discussion as tools for development of reflection/Reflective e-portfolio (1, 5), Test-enhanced learning (6), Scenario-based learning interface (7), Multimedia information sequencing (8), Interactive distance learning (9), Problem-based learning (PBL) (10), and Felder and Soloman's index of learning styles (11). The participants for the studies were undergraduate dental students (6) and postgraduate orthodontic students (1, 5, 7–11). Seven studies had a set amount of time as learning style intervention (1, 5–10). The time ranges were between thirty-five mins (9) to one year (1). All the eight studies highlighted a positive outcome with six studies (1, 5, 7, 9–11) assessing the students' attitudes. Four studies (1, 7, 9, 11) reported that students found their learning styles effective and engaging, worthwhile and comfortable with adequate access to technological assets. One study (9) reported that 76% of responding faculty and 84% of responding residents in their study wanted to use the distance learning style again in the future whereas (5, 10) reported conflicting results with students experiencing acceptability issues and that PBL was a challenge which needed to be overcome as a journey and not as separate individual learning event.

## DISCUSSION

The review of eight selected studies reveals unique learning styles utilised in orthodontic education. Using the PICO process, students and orthodontic residents formed the population, the intervention was

through the learning styles employed, and comparison was between test and control groups with outcomes studied through knowledge gain and students' attitudes.

The learning styles of students have been shown to change as the student progresses in their academic years (12). The findings from another study suggest that the theoretical lectures and practical sessions of the preclinical training years (first- and second-year) exhibit assimilating learning style (13, 14). This style then changes to a diverging learning style during the clinical years as ascertained by a similar study (3).

Two studies by the same author (1, 5) have used reflection as a means of evaluating outcomes wherein the importance of self-reflection is seen as an effective tool for the development of reflection in learning.

A thematic approach to understanding reflection, its characteristics and outcomes were studied highlighting the implementation of a reflective strategy (1). The study, however, has a limited understanding of whether the students will maintain a reflective and self-critical approach in the long term.

Reflective e-portfolio was found to have five aspects of reflection (5). The study revealed conflicting results on the acceptability. The mentors showed a positive attitude whereas the students' expressed concerns on all the five aspects of relevance, time requirement, support mentoring, implementation method, and the electronic method used. The study has drawn acceptability issues from a lack of specificity, inadequate communication amongst students, and the absence of a good relationship between mentors and students. These factors create a hindrance to the use of reflective e-portfolio in higher education.

The test enhanced approach (6) examined the outcome of students by evaluating test grades which were found to have a significant benefit at 95% confidence intervals compared to the traditional group. The test-enhanced group performance was

better than the traditional group with more consistent demonstrations of competence with the percentage of students receiving A grades increasing by more than two confidence intervals. The study with its limitations was still able to provide an understanding of test-enhanced learning in orthodontic education with the better overall quality of grades and performance.

Scenario Based Learning interactive (SBLi) modules assessed the strengths and weaknesses of nine orthodontic modules (7). The modules were considered engaging with greater confidence in the application of clinical skills. The study limitation occurred with a very small group of nine students and hence the outcome is insignificant though provides a valuable resource on student responses on strengths and weaknesses for designing future methods of instruction.

Influence of multimedia sequencing using instructional multimedia programmes in postgraduate orthodontic training identified that hierarchical sequencing (HS) model may match the learning styles of the majority of the dental students. The HS model revealed significant learning gains and an improved estimate of post-test and gain scores in the test group when using computer-assisted learning (CAL) as a learning tool (8). The score of the test group who studied the HS modules improved by 1.75 ( $p = 0.05$ ) compared with the control group. The HS models did not have any specific and significant effect on the knowledge and understanding levels of the subject matter. The outcomes of the HS model can be considered for goal-orientated sequencing in orthodontic training.

Interactive distance education (9) highlighted that blended learning and technology was found to be well accepted by students and faculty with 84% of the student respondents willing to use the technology again. The study highlights the inexpensive management of quality distance learning which might be the next major drift with more and more students studying online.

PBL was studied using qualitative methods to identify issues of PBL (10). The study has shown a mixed outcome with students seeing PBL as a challenge and accepting the learning cycles to be a non-individual learning experience. The students experienced conflicts within themselves and between the group based on their positive and negative experiences with PBL.

The study utilising Felder and Soloman's index was used to identify the learning style amongst 261 survey respondents (11). The study survey received a response of 26% which might have come from individuals who were interested in education and learning styles which creates a bias in responses. The study has highlighted a very interesting aspect of learners amongst orthodontic residents with the survey revealing few global learners and more sequential learners. This answers the overall question of fewer researchers and declining number of faculty in orthodontics as the majority of sequential learners prefer to remain clinicians owing to their innate learning qualities.

Out of the eight studies reviewed, five studies have involved postgraduate students as their test subjects (1, 5, 7, 10, 11). Postgraduate and undergraduate students were utilised in one study to determine the effects of hierarchical sequencing (8). A study to understand the effectiveness of test-enhanced learning utilised undergraduate students entirely (6). However, the limitations of these studies are seen in the sample size employed. This limitation may be a direct result of the small number of postgraduate students enrolled in orthodontic courses as reflected in these studies (1, 5, 7, 10, 11). The outcomes of these studies are difficult to generalise and thereby become insignificant for a larger application. Lack of randomisation with the absence of control and test groups was evident in one of the studies (6). The distance learning (9) might have implications for the technological limitations of internet connectivity and video playback

options which might affect students from a resource-poor setting.

The limitations of sample size and its shortcomings can be addressed by collaborating with similarly sized cohorts from other universities nationally and globally to have a strong statistical significance. The limitations of internet connectivity have been addressed by improvements in technology and inexpensive internet globally and innovations in video playback software with a multitude of playback options.

## IMPLICATIONS

It is prudent to recognise the learning styles of orthodontic students' as their perception of learning is a subject that has received little attention from dental and orthodontic educators (15). The review which reveals a sound understanding of learning strategies has many beneficial implications for both students and mentors (16). A meta-analysis (17) found a strong correlation between tailored instruction and increased academic achievement and improved attitudes to students' learning. The study highlights the importance of involving students in recognising the learning styles in an attempt to understand the effects on curriculum design matching the students unique learning strategies. Understanding these areas will not only enable the establishment of a better communication and interaction between students, faculty and the learning content (16) but also have a direct influence on the level of clinical experience (3). The identification of learning styles helps channel students with a range of learning abilities to seek newer experiences and outcomes effectively thereby improving the quality of orthodontic training. The different strategies highlighting learning styles employed for and by orthodontic residents were designed to meet a certain objective

of either knowledge gain or acceptance by the students. Matching the teaching and learning styles have shown to effectively reduce the time requirements for learning a new task (18). The results from this review further contribute to the literature by identifying the strategies adopted and their influence on the outcomes of learning. The strategies; big or small will necessitate an inclusion of specific techniques supporting students' needs. Knowing these strategies will enable improved impressions of dental school experience and develop better learning pathways.

## CONCLUSION

This review utilised eight studies to gain a wider understanding of the learning styles of orthodontic residents. The learning styles though are different not always contribute to a better outcome or academic performance (19). The number of studies reviewed is small which highlights the need for further exploration and studies. The learning styles and preferences should be assessed individually and collectively to seek a better understanding of how the orthodontic residents prefer the knowledge source to be disseminated. A larger study collaborating with larger cohorts from other universities nationally and globally is required to gather and establish a concrete understanding of techniques used, styles delivered, and ideas developed. This will enhance the knowledge flow and delivery utilising the right tools to integrate a particular type of learning to a particular individual or group. Developing an effective teaching method that complements a wide range of learning styles appears to be more conducive and beneficial to the overall development of orthodontic residents than attempting to tailor the course content to the individual student. This integration will further allow students to follow their own learning styles rather than follow one style employed on all.

# APPENDIX

## Detailed description of studies included for the review

Authors	Learning styles	Aim of the study	Number of subjects	Learning strategy used	Learning assessment	Study characteristics	Study outcome measures	Result	Attitudes
Tonni, Mora, Oliver (2016)	Portfolios and discussion as tools for development of reflection	To analyse the effects of a portfolio learning strategy.	First-year postgraduate students (n = 9), mentors (n = 7)	Reflective strategy with its 3 components namely reflective writing, meeting with the mentor, and peer discussion.	Focus groups and individual interviews.	One-year programme, which included a reflective portfolio, mentorship, and discussion.	Reflection, characteristics of reflection, outcomes of reflection, and stimulation of reflection.	Reflective e-portfolio helped students in the reflective process.	Students and mentors considered the strategy an effective tool for improving students' reflection.
Freda, Lipp (2016)	Test-enhanced learning	To evaluate test-enhanced experiences on demonstrations of competence in diagnosis and management of malocclusion and skeletal problems.	Third-year dental students: 2011 (n = 88), 2012 (n = 74), 2013 (n = 91), 2014 (n = 85)	A series of case-based assessments with written and dialogic feedback.	A final session of a summative assessment consisting of the same four cases was administered. Students constructed a problem list, treatment objectives, and a treatment plan for each case scored according to the same criteria.	The students received six 2-hour sessions, spaced one week apart. The 2013 and 2014 groups received the test-enhanced method emphasising formative assessments with written and dialogic delayed feedback. The 2011 and 2012 groups received the traditional approach emphasising lectures and classroom exercises.	Performance grades based on the number of cases without critical errors.	Test-enhanced groups demonstrated statistically significant benefits at 95% confidence intervals compared to the traditional groups when comparing low- and high-quality grades.	Not assessed.
Naser-ud-Din (2015)	Scenario based learning interface (SBLI)	To develop 9 interactive modules for the teaching of orthodontics and to qualitatively evaluate the project using questionnaires both before and after.	Postgraduate students (n = 9)	Writing down, summarising, discussing, reinforcement with revision, revisiting lecture notes, using past exam papers as prompts, mind maps, self-testing, reading of extra texts, discussion with experts, use of diagrams, and peer discussion.	Pre-module evaluation with open ended questionnaire and Post-SBLI evaluation with open ended questionnaire.	The students had 5 months of SBLI access to 9 interactive modules.	Students' responses to strengths, weaknesses, and suggestions.	High acceptance rate, greater confidence in the application of clinical skills covered in the modules and reduced contact time particularly with limited academic staff.	The modules were considered engaging.

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**Appendix (Continued)**

Authors	Learning styles	Aim of the study	Number of subjects	Learning strategy used	Learning assessment	Study characteristics	Study outcome measures	Result	Attitudes
Tonni, Oliver (2013)	Reflective e-portfolio	Students' and mentors' acceptability of a reflective e-portfolio.	Postgraduate students (n = 6), mentors (n = 7)	Evaluation research approach involving the implementation, evaluation and modification of a reflective e-portfolio.	Questionnaires	Each student was given a PDA pre-loaded and configured with the e-portfolio elements and a foldable keyboard. The students compiled the orthodontic e-portfolio for the first 2 months of their second year of training.	Acceptability of the reflective e-portfolio was collected through 2 questionnaires, 1 for students and 1 for mentors. The semi-structured questionnaires were distributed using Blackboard, and participants were asked to complete and return them within 1 week. Students and mentors were asked to rate the statements regarding the reflective e-portfolio on a Likert-type six-point scale.	A total of 11 (84.6%) of the 13 questionnaires were returned. Responses were received from 100% (6/6) of students, whereas 71.4% (5/7) of the mentors replied.	Students' response highlighted acceptability issues related to the e-portfolio. Mentors showed a more positive attitude towards the e-portfolio, expressing only some concerns about the time involved in using it.
Aly, Willems, Van Den Noortgate, Elen (2011)	Multimedia information sequencing	To compare the effectiveness of hierarchical sequencing (HS) versus elaboration sequencing (ES) models in improving educational outcome of clinical knowledge when using instructional multimedia programs in postgraduate orthodontic training.	Postgraduate students (n = 24), undergraduate students (n = 24)	12 instructional multimedia programmes with 6 logically sequenced (LS) modules discussing 6 different orthodontic topics and another 6 modules on identical topics were sequenced according to one macro-sequencing (MS) model.	Pre- and post-evaluation tests of each pair of participants.	All participants were assigned to consistent pairs of students and were randomly divided into a test and a control group. In each pair, one student studied the LS module (control group) while the other studied the MS version (test group). The students were allowed 5 logins of maximum 2 hours for 3 weeks.	Knowledge, understanding and application of each participant with regard to the discussed topic.	The HS model may improve educational outcome when using instructional multimedia programmes in postgraduate orthodontic training.	Not assessed.

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Appendix (Continued)

Authors	Learning styles	Aim of the study	Number of subjects	Learning strategy used	Learning assessment	Study characteristics	Study outcome measures	Result	Attitudes
Klein, Hannum, Fields, Proffit (2012)	Interactive distance learning	To evaluate interactive distance education for orthodontic residents.	Orthodontic programmes (n = 33)	Observation of web-based seminars with live post-seminar discussions.	Knowledge gain measured by post-intervention survey.	Reading assigned journals. Viewing a 35 to a 90-minute recording of an actual classroom seminar on the website. Participating in a 30-minute follow-up discussion with faculty.	Perceptions of the blended learning experience. Perceptions of the technology.	The majority of responding faculty members (79%) and residents (74%) thought this form of distance learning was effective as a teaching tool. Most responding residents (72%) agreed they were not distracted from learning because of the technology.	76% of responding faculty members and 71% of responding residents thought the time spent was worthwhile; and 76% of responding faculty members and 84% of responding residents said they wanted to use distance learning materials again in the future.
Bearn, Chadwick (2010)	Problem-based learning (PBL)	To evaluate the experiences of postgraduate students undertaking a PBL based postgraduate programme.	A single cohort of postgraduate orthodontic students (n = 12)	15 PBL cases were studied by the groups.	Focus groups and semi-structured interviews were used to investigate students' experiences.	PBL sessions for two groups of 6 students, and 5 scheduled 1 hour sessions.	Aspirations and expectations of students.	PBL led to significant tensions both within the individuals and the group, caused by the conflict between appreciating PBL as a 'good thing' and yet finding that 'it just doesn't seem to work'.	The students entered the programme with high expectations, but soon found they had challenges to overcome. They came to realise that they were on a journey, rather than undertaking a sequence of separate individual learning events.

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**Appendix (Continued)**

Authors	Learning styles	Aim of the study	Number of subjects	Learning strategy used	Learning assessment	Study characteristics	Study outcome measures	Result	Attitudes
Hughes, Fallis, Peel, Murchison (2009)	Felder and Soloman's index of learning styles	To determine the distribution of learner types in graduate orthodontic residency programmes in the United States and Canada as determined by Felder and Soloman's index of learning styles; and second, to provide insight and guidance for course designs that best support the graduate orthodontic resident's learning preferences.	Survey responses (n = 261)	Survey study	Online survey	The survey consisted of 44 questions, each with two answer choices.	Student learning preferences in 4 dimensions using dichotomous scales. Questions about residents' access to the internet and comfort level with online learning so as to address acceptance of web-based courses in response to the shortage of full-time faculty members.	Visual learner (72.4%), balanced verbal learner (24.1%), sequential learner (36.8%), balanced global learner (55.6%), active learner (7.7%), balanced reflective learner (59.4%), sensing learner (18.8%), balanced intuitive learner (52.5%), intuitive learner (8.4%).	Residents are comfortable with and have adequate access to current technological assets; therefore, they may be well suited for the inclusion of computer-based teaching modules and other multimedia devices in their residency curriculum.

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