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Original Article

Dentistry Section

Influence of Teaching Strategies and its Order of Exposure on Pre-Clinical Teeth Arrangement – A Pilot Study

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ABSTRACT

Introduction: Teeth arrangement is a vital skill for the undergraduate dental student. The attainment of skills depends largely on the methodology of teaching. In a dental curriculum, the students are exposed to a wide variety of inputs and teaching methodologies from different sources. The educational unit in dental school must identify the sequence of teaching methods that enhance the learning and practising ability of students.

Aim: The aim of this study was to evaluate the effectiveness of three different teaching methodologies for teeth arrangement and compare the differences between the orders of exposure to each teaching methodology on the development of teeth arrangement skills.

Materials and Methods: The first year B.D.S students were study participants and were divided into three groups A, B, C. They were exposed to three teaching patterns namely live demonstration with video assisted teaching, group discussion with hand-outs and lectures with power point presentation. After each teaching methodology, their skill was assessed. The groups were exposed to three methodologies in different order for three arrangements. The scores obtained were analysed using Kruskal Wallis rank sum test and Dunn test for statistical significance.

Results: Significantly higher scores in the teeth arrangement procedure were obtained by the Group A students who were exposed initially to live demonstration with video-assisted teaching. Difference in the scores was noted among and within the groups. The difference between Group A and Group C was statistically significant after both first and third teeth arrangement (p=0.0031, p=0.0057).

Conclusion: The study suggests each pre-clinical practice should begin with a live demonstration to enhance immediate learning absorption followed by lectures with power point presentation and group discussion for retention of knowledge and memory retrieval.

Keywords: Blended teaching, Live-demonstration, Pre-clinical dental curriculum, Teeth arrangement skill

INTRODUCTION

The undergraduate dental curriculum in most of the Indian Dental Schools comprises of dental procedural and laboratory skills, these skills are taught and learned within a stipulated time of four years. One of the major teaching and learning objective of the pre-clinical curriculum is the skill that is acquired in the arrangement of artificial teeth and the subsequent steps in fabrication of a complete denture removable prosthesis. Teaching such, a laboratory exercise requires that the students gain an abstract understanding of the process of denture fabrication [1]. When students undergo dental training, they are exposed to a wide variety of inputs and teaching methodologies from different sources. The most widely used aids are lectures with power point presentation with or without videos, group discussion and live demonstration. The first use of computers as a learning tool in the dental field was reported in the early seventies when Computer Aided Learning (CAL) was developed as a part of a dental curriculum at the University of Kentucky [2,3]. Classroom based lectures are probably the best teaching method in many circumstances for communicating conceptual knowledge. Lectures supplemented with video and power point presentations are being widely used for teaching and training technical skills, simulating clinical situations in dentistry [4]. Group discussion offers space for students to develop rapport and explore their doubts. Live demonstration is effective in explaining the procedure in a sequential manner, which makes the student perform the skill independently. Live demonstrations and the videotaped presentations of the same were found to be equally effective in transmitting pre-clinical knowledge and clinical skill for first time learners [5-8]. Blended learning approach is a combination of two or more teaching methods like e-learning with traditional instructor training [9]. When the students are exposed to such variety of teaching methods and have an access to more than one method of learning skills, the information has a better chance of being understood, retained and reproduced. The objective of the present study was to evaluate the effectiveness of three different teaching methodologies for arrangement of artificial teeth and to evaluate the ideal order of teaching in the development of the skill.

MATERIALS AND METHODS

The study was formulated as a randomized unblinded educational intervention of pre-clinical teaching for a period of one year. The participants were 75 first year dental undergraduate students from Faculty of Dental Sciences, Sri Ramachandra University, Chennai, Tamil Nadu, India. The students were divided into three groups namely Group A, Group B and Group C (n=25) using systematic random sampling. The sample size and power of the study was arrived with a ratio of 1:1 using assumed mean score of 60 points and an improvement 7 points for the groups with a standard deviation 8 and 9, and was computed using the software from

Open Source Epidemiologic Statistics for Public Health version 3.01. All students who participated in the study had no prior exposure to any teeth arrangement skill and had zero baseline knowledge in the field of dentistry. This study was an evaluation of the teaching methodologies that are routinely practiced in the pre-clinical laboratory in all the dental institutions throughout the country and has been recognised by the Dental Council of India. It did not incorporate any additional or new methods, which could affect students' work schedule. The skill that was evaluated was a part of the pre-clinical curriculum that the students are expected to perform in the first year B.D.S. The study did not involve any ethical issues that will be experienced by the student participants, as it did not interfere in any personal issues or require extra time from the students as the study was carried out during the allotted laboratory hours inside the premises of the institution. Ethical committee approval was not found to be essential. The study commenced with the approval of the Dental Education Unit of the University and the Head of the Department of Prosthodontics after obtaining consent from all of the students. The students who gave a written consent were included in the study and there was no specific exclusion criterion for the study as it was part of the pre-clinical curriculum followed by all the students in their first year.

Group A, B and C were exposed to three different teaching methodologies and were instructed to complete three teeth arrangements, the order of the teaching methodology for each of the three arrangements are depicted in [Table/Fig-1]. Each study participant fabricated three sets of articulated edentulous maxillary and mandibular occlusal rims approved by a single instructor to ensure uniformity. The instructor who has completed his Masters in Prosthodontics, with an academic experience of seven years in handling clinical and pre-clinical work, and a qualified examiner for final pre-clinical examinations conducted the study. He objectively evaluated the three teeth arrangements of each participant using a scoring system with points. The points for the scoring system were formulated by assigning points for each step in the exercise that are vital in completion of the teeth arrangement [Table/Fig-2].

The study was carried out in the allotted pre-clinical laboratory hours for the first year students in the dental curriculum. Four laboratory classes each three hours in duration were utilized for completing one teeth arrangement for the respective teaching methodology. A duration of three laboratory classes were given in-between each change in teaching order for the students to prepare the articulated models for the next teeth arrangement.

	First Setting	Second Setting	Third Setting
GROUP A	Live demonstration	Group discussion with hand- outs	Lectures with power point presentation
GROUP B	Group discussion with hand-outs	Lectures with power point presentation	Live demonstration
GROUP C	Lectures with power point presentation	Live demonstration	Group discussion with hand-outs

[Table/Fig-1]: Distribution of groups.

Scoring (100 Points)	
Maxillary Anterior Placement	5
Mandibular Anterior Placement	5
Maxillary Posterior Placement	5
Mandibular Posterior Placement	5
Maxillary Anterior Arrangement	10
Mandibular Anterior Arrangement	10
Maxillary Posterior Arrangement	15
Mandibular Posterior Arrangement	15
Arch Form and Symmetry	10
Occlusion	10
Neatness	10

[Table/Fig-2]: Scoring system for evaluation of teeth arrangement.

Group A students were exposed to a live demonstration of teeth arrangement. Group B students were exposed to group discussion and the students were provided with hand-outs, to be followed during teeth arrangement with diagrams. Group C students were exposed to classroom lecture where the individual position of different teeth was illustrated using pictures projected from different angulations on a power point presentation. All three groups had a single instructor to avoid bias. Once the three groups completed their respective classes, they were asked to proceed with one teeth arrangement each. In the process of teeth arrangement students had access to the material used for their respective teaching. Group A was given access to a completed teeth arrangement on which demonstration was given and a recorded video of the demonstration was made available on a projected screen for reference, Group B was given access to the hand-outs of teeth arrangement principles [10], Group C had access to power point presentation with photographs. The videos used for the study purposes were recordings that were made when the instructor was giving the live demonstration. The pictures used in the study for teaching were made ready by the instructor following standard textbooks prior to commencement of the study. The hand-outs used in the study were taken from the standard textbooks used by the students. No online pictures or videos were used in the study. The students were not allowed to carry their articulators home, discuss or access teaching material with another group. The materials such as hand-outs and videos that were used for teaching were taken back from the students once the teeth arrangements were completed and submitted. The teaching methodology was changed in each group for the second and third teeth arrangement, at the end of the third teeth arrangement, each student was exposed to three different teaching methodology, the difference between the order of teaching pattern they were exposed to, is explained in the [Table/Fig-1].

The mean, standard deviation and median scores were computed for each arrangement among the groups. Inter-group comparisons were performed using Kruskal-Wallis rank sum test and this was followed by inter-group comparisons using the Dunn's test. R statistical software version 3.2.3 was used and for the intra-group comparisons, the "PMCMR" package for R was used.

RESULTS

The scores for all three groups at the end of three teeth arrangements were tabulated and average scores for each group were calculated [Table/Fig-3-5]. The scores were tabulated only for the students who completed their teeth arrangement in the scheduled time. Students who were irregular for the class or were unable to complete all the three teeth arrangement in the stipulated period due to absence for their own reasons were removed during statistical analysis. Six candidates were excluded from the study, Group A had two drop-outs due to incomplete work, Group B and Group C each had one drop-out due to incomplete work and one due to personal reasons. The mean, median and standard deviation for all the three groups and their corresponding scores were calculated and were statistically analysed. It can be observed that there is difference in mean scores among the groups for all the three arrangements. On statistical analysis using Kruskal Wallis rank sum test there was significant difference among the groups at the end of the 1st teeth arrangement (p=0.0045) and the 3rd teeth arrangement (p=0.0059) [Table/Fig-6]. There were no statistically significant results observed among the groups in the second teeth arrangement (p=0.4193). It was observed that mean, median scores were higher in Group A when compared

S.No.	First Setting (LD)	Second Setting (GD)	Third Setting (PPT)
1.	50	47	59
2.	42	51	52
3.	49	66	66
4.	32	55	66
5.	33	85	68
6.	49	59	80
7.	34	35	56
8.	68	63	65
9.	62	59	75
10.	62	74	72
11.	52	64	57
12.	52	62	60
13.	48	47	60
14.	62	68	68
15.	49	56	60
16.	42	58	58
17.	49	66	64
18.	62	64	59
19.	75	58	67
20.	67	60	66
21.	72	82	77
22.	57	66	80
23.	41	48	49

[Table/Fig-3]: Scores obtained by Group A for the three teeth arrangement.
PPT-Power point presentation, LD-Lecture demonstration, GD-Group discussion

S.No.	First Setting (LD)	Second Setting (GD)	Third Setting (PPT)
1.	37	39	54
2.	32	32	57
3.	46	57	46
4.	49	67	59
5.	36	33	55
6.	51	43	59
7.	36	56	64
8.	54	52	60
9.	33	56	60
10.	41	61	69
11.	48	72	65
12.	42	59	58
13.	30	40	52
14.	53	67	78
15.	36	52	70
16.	50	59	60
17.	49	56	56
18.	52	54	60
19.	50	65	69
20.	74	72	82
21.	48	57	57
22.	68	66	75
23.	60	71	69

[Table/Fig-4]: Scores obtained by Group B for the three teeth arrangement.
PPT-Power point presentation, LD-Lecture demonstration, GD-Group discussion

to Group B and Group B had better scores compared to Group C. The Dunn's test for inter-group comparisons between Group A and Group C was statistically significant in first arrangement (p=0.0031) and third arrangement (p=0.0057) [Table/Fig-7]. At the end of the third teeth arrangement on comparison of scores Group

S.No.	First Setting (LD)	Second Setting (GD)	Third Setting (PPT)
1.	36	46	52
2.	35	54	60
3.	27	51	47
4.	44	66	66
5.	27	63	42
6.	64	61	59
7.	43	52	62
8.	38	53	53
9.	39	59	58
10.	39	61	55
11.	34	63	57
12.	37	70	56
13.	37	60	55
14.	52	58	56
15.	42	39	46
16.	39	58	33
17.	31	65	51
18.	53	58	55
19.	36	55	70
20.	44	54	59
21.	46	61	68
22.	36	59	57
23.	51	57	76

[Table/Fig-5]: Scores obtained by Group C for the three teeth arrangement.
PPT-Power point presentation, LD-Lecture demonstration, GD-Group discussion

Groups	First Teeth Arrangement				Second Teeth Arrangement				Third Teeth Arrangement			
	Mean	Median	SD		Mean	Median	SD		Mean	Median	SD	
A	52.6	50	12.2	p=0.0045	60.5	60	11.2	p=0.4193	64.5	65	8.3	p=0.0059
B	46.7	48	11.1		55.9	57	11.8		62.3	60	8.7	
C	40.4	39	8.6		57.5	58	6.7		56.2	56	9.2	

[Table/Fig-6]: Mean score of teeth arrangement at each sitting among the groups showing Kruskal Wallis rank sum test

Inter-group comparison	First Teeth Arrangement	Third Teeth Arrangement
A vs B	0.1488	0.3830
B vs C	0.1488	0.0514
A vs C	0.0031*	0.0057*

[Table/Fig-7]: Pairwise comparisons using Dunn's-test for multiple comparisons of independent samples.
*=Statistically significant
p-value≤ 0.05 statistically significant

A>Group B >Group C. The order of teaching followed for Group A revealed better retention and reproducibility of the skill followed by Group B, which revealed that the teaching pattern taught in first teeth arrangement influenced the students' performance in the subsequent arrangements.

DISCUSSION

Development of a skill involves the concept of learning, by which a learner improves performance through practice until the correct performance of the motor skill becomes automatic [11]. It is essential for the student to conceive the knowledge during their early learning stages especially at the pre-clinical years. Pre-clinical curriculum in complete denture removable prosthodontics involves teaching and learning of fundamental laboratory and clinical steps [1]. It involves fabrication of a completely edentulous model over which a trial denture base with occlusal rims to be fabricated. Teeth arrangement would be done on this mock model

simulating patient's jaw to perform better on clinical procedures. The students are expected to perform this skill in stipulated period of time following standard teeth arrangement principles [10], which is evaluated at the end of their pre-clinical curriculum. Teaching any procedure to a first year undergraduate student with no clinical exposure will only make them an observer [12], which in turn reflects in learning, grasping, retaining and reproducing the skill; hence, it requires sequential emphasis of these procedures and subsequent evaluation of the skill.

Learning in small groups enables the students to observe the procedure and learn with more clarity and interaction. It provides an opportunity for each student to participate, and interact with the operator [13], also charges the student with the responsibility for learning and checking themselves through self and peer evaluation [1]. However, demonstrations to small group of students are time consuming but they increase the perception of confidence in dental students [7,14]. This study involved three small groups, who were exposed to different teaching methodologies in different orders as depicted in [Table/Fig-1]. The order of teaching showed difference in performance among the groups and Group A students who were initially exposed to live demonstrations performed better at the end of first and third teeth arrangement exercise.

Lectures, seminars, reading assignments and laboratory experiences are instructional methods used to teach new concepts to dental students but they fall short in teaching the technical aspects of clinical procedures [13]. Lectures are usually monotonous and they fail to impart a skill, they give only an outline of a procedure. Group C students, who were exposed to lectures in their first teeth arrangement had obtained lesser scores when compared to other groups. Lectures can help students to acquire knowledge about basic principles of arrangement but the position, placement and the errors cannot be judged. Group B students who were exposed to group discussion with hand-outs performed better than Group C but had obtained lesser scores when compared to Group A. Hence, these methods are considered to be passive with respect to students' participation in the learning process and have questionable learning outcomes [1]. Statistically significant results were obtained between Group A and Group C at the end of first teeth arrangement ($p=0.0031$).

Demonstrations on an articulated model by an instructor focus on the skill to be learnt. Such live demonstrations was found superior to other forms of teaching, leading to increased student confidence, communication skills and greater understanding of procedures [13,14]. Study done by Bazyk et al., showed that their students expressed a preference for live demonstrations as they allowed them the opportunity to ask questions, interact with the instructor, understand difficulties and errors during the progress of the procedure [15]. Group A students were exposed to live demonstration and were allowed to view the video recording, which enhanced their learning and retaining the skill. This improved sensitisation of the learned skill through video-assisted instruction, overcomes shortfalls, enables better visualizations of practical techniques during small group teaching [7,13,16-18]. A procedural video that is well designed and developed can be equally effective as a live demonstration. In addition, they have an advantage as the students can review the video any time when compared to live demonstration where everyone crowds around the instructor [5].

Video assisted teaching is also a cost-effective way of conveying new knowledge, especially when there is a shortage in academic staff as they require less time than conventional teaching methods [19,20]. Updating electronic content is easier than printed material where the learners can tailor their experience to meet personal learning objectives [21]. Videos that explain the procedural steps can be accepted as a good teaching tool that will allow better visualization of the steps on a larger screen and act as an audio and video stimulation for the students [5,22]. Comparative research has also shown that video-based instructions are superior to traditional lectures [13,17,23] but unlike a teacher who actually taught and perhaps, offered explanation, the students cannot depend on a computer to elaborate on specific points, which showed none of these methods replaces live demonstrations and students' active participation [24]. Studies done by Devitt et al., and Holt et al., also showed that instructional multimedia could only be used as a complementary method of teaching [25,26].

No other form of teaching is beneficial to beginners or slow learners in pre-clinical years. Hence, a blended curriculum approach is needed to allow flexibility, easy access for updating information, face-to-face interaction, decrease the repetition and lessening the demand for faculty supervision in an increased class size [9]. It also encourages the students to learn and has positive effect on students motor performance [27,28]. In this study, the three teaching patterns were imparted to all the groups in different order. Difference in scores were observed among groups for the three teeth arrangements which revealed that in a blended teaching curriculum the order of teaching would show a significant difference in students' learning ability. Pre-clinical curriculum and student's performance are crucial in deciding their skill before they diagnose and treat patients in the dental clinics. The knowledge they acquire must be rightly perceived through a proper teaching methodology, which enables them to correlate and apply it with clinical reasoning. Teaching methodologies for beginners have a direct impact on the quality of treatment rendered to patients. Retention of acquired knowledge is influenced by the order of teaching methodology, visual teaching patterns showed a higher retention than lectures and group discussions [29,30]. Hence, this study was conducted with a motive to improve the present curriculum and to achieve an ideal order of teaching to help students in acquiring a concrete and sustained knowledge.

LIMITATION

The limitations of the study were that, a single instructor was appointed for all the teaching methodologies and the operator fatigue could have affected the outcome of the study. The knowledge acquired by the students from a single instructor would be limited. Additional instructors and evaluators in groups could have been added to conduct the study for first year students consecutively to minimize bias.

CONCLUSION

The results of the present study implies the need for a teaching methodology that helps the first time learners to observe, learn, practice and reproduce the acquired skill in a pre-clinical laboratory. The order of teaching in a pre-clinical curriculum greatly influences the knowledge acquired by the student and this concrete knowledge is essential for each student to perform in clinical situations. Live demonstrations with video assisted teaching followed by other methods have shown better results which suggest that each pre-clinical practice should begin with a live demonstration to increase the immediate learning absorption followed by lectures with power point presentation and group discussion for retention of knowledge and memory retrieval. A multi-centre study in different dental schools with instructors who follow the similar pre-clinical curriculum will help to validate these results.

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