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ORIGINAL ARTICLE

Instructional Design for Assessment of Dental Esthetic Treatment Needs in a Indian Undergraduate School: A Randomised Controlled Trial

Sunila B. Sangappa · Avinash V. Mehendale

Abstract In the recent years esthetic dentistry has been the area of focus amongst the public. Esthetics is an important dimension in dental practice and the upcoming dentists need to be enabled to demonstrate their competencies for an efficient clinical outcome. The purpose of this study was to institute a cultural change within traditional didactic dental education towards student centred learning to cope up with the accelerating pace of medical technological change and achieving positive impact on patient care and patient satisfaction. Intervention that was considered for the project included David Merrill's first principles of instruction. A randomized controlled trial was conducted with all the students from four cohorts of final year dental undergraduate students, divided into an intervention group ($n = 40$) and a control group ($n = 40$). A professional assessment questionnaire is used to evaluate the relationship between the students and professional's assessment of esthetic treatment needs. The results of the study indicated that the ranking of the most and least noticeable dental features differed significantly ($p = 0.0061$) between the intervention and non intervention group and the indicates the intervention group to be in better agreement with professional assessment than the non intervention group of students with z value of 2.7435. The relative agreement between intervention group of undergraduate students and the professional assessment of esthetic treatment need shows the importance of intervention of Merrill's first principles of instruction in learning, emphasising the significance of PBL and therefore indicating a positive impact on successful esthetic treatment for patients.

Keywords Student centered learning · Esthetic treatment needs · Professional assessment

Introduction

Interest in esthetic dentistry has increased enormously in recent years in the dental community and the general public alike. Recent development in implant dentistry has turned also from the initial focus on biology and function to greater awareness of esthetic results. Today most conferences on oral implants place considerable emphasis on esthetics and a detailed description of clinical techniques to enhance natural appearance [1]. As caries and periodontal disease become controlled, the area of cosmetic dentistry is destined to play a more prominent role in general practice [2].

According to DJ Miller, trained and observant eye readily detects that which is out of balance, asymmetric and out of harmony with its environment [3]. The preoccupation that society has with maintaining youthful appearance is not limited to the young. The older adult of the 1990s are as sensitive as the teenager to dental esthetics [4].

The discrepancy between the students and professional assessment of dental esthetic treatment needs will definitely give rise to problems when it comes to esthetic treatment planning. In order to achieve a better agreement

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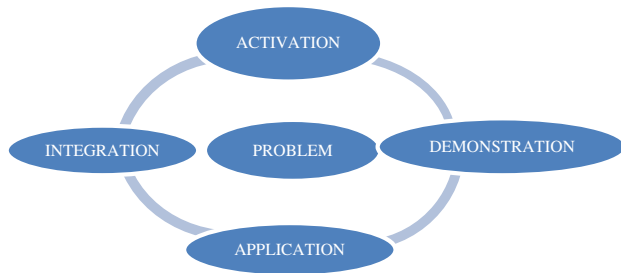e-mail: mehendaleav@gmail.com

Fig. 1 Phases for effective instruction

between the professionals and undergraduate students, the need of the hour is to change the culture. It is envisaged that medical education should become much more student centered with the undergraduates of future being encouraged to become active and self directed participants in their learning [5]. Learning is important because no one is born with the ability to function competently as an adult in society. It is especially important to understand the kinds of learning experiences that lead to transfer of knowledge, which is defined as the ability to extend what has been learned in one context to new contexts. Transfer can be improved by helping students become more aware of themselves as learners who actively monitor their learning strategies and assess the readiness to particular tests and performances. A number of studies converge on the conclusion that transfer is enhanced by helping students see potential transfer implications of what they are learning, i.e., understanding when, where and why to use new knowledge [6].

After the origin of PBL in medical education at the Mc Master University in Canada in the 1960s [7] the role and advantages of PBL as an innovative approach in health professions education has been well documented [8, 9]. Problem-based learning curricula have been introduced in many medical schools around the world [10, 11]. Teachers are expected to change their traditional approach and become facilitators of learning [7]. Based on the clinical education literature and the resources available, the purpose of this article was to cope up with the accelerating pace of medical technological change and achieving positive impact on patient care and patient satisfaction by instituting a cultural change within traditional didactic dental education towards student centred learning by development and implementation of instructional design that was offered for the first time to the final year, second-term dental undergraduate students during the 2011–2012 academic year. Many current instructional models suggest that most effective learning environment are those that are problem centered. Intervention that was considered for the study included David Merrill's first principles of

instruction (Fig. 1). [12] and stated in the most concise form as, learning is promoted when learners are engaged in solving real-world problems, when existing knowledge is activated as a foundation for new knowledge, when new knowledge is demonstrated to the learner, applied by the learner, and integrated into the learner's world. The research question addressed in conjunction with this study implementation was the following: Does the assessment of esthetic treatment needs and variations by the final year dental undergraduate students influenced by the method of learning? The hypotheses tested was.

- The ranking of the least noticeable dental features will differ significantly with the intervention and non intervention group.
- Final year undergraduate students of the intervention group will be more perceptive than the non intervention group of students.

Method

A cohort of eighty final year second-term dental students was solicited for the study. The subjects in the study were females ($n = 63$; 79 %) and males ($n = 17$; 21 %). They ranged in age from 21 to 22 years. The cohort was divided randomly into four subgroups of 20 students for each clinical posting. Samples for the study (80) were comprised of two experimental groups (40 students) and two control groups (40 students) respectively using a random sampling technique. All the participants had continuous natural dentitions with natural teeth or fixed restorations. Attendance and participation for the experimental group included for the study were mandatory. Approval by the institute's Institutional Review Board was obtained. The subjects gave written informed consent to the study procedures.

Duration of clinical postings for each batch of 20 students was 30 days with 4 h per day. This research study was carried out as a part of the routine clinical work using one clinical hour of each day for the intervention group of students who were already exposed to traditional teaching of the topic as according to the curriculum, along with non intervention group. Problem in the form of task given for the intervention group of students was peer assessment of esthetic treatment needs. Two double-blinded calibrated prosthodontists of the department independently evaluated the students (peer simulated patient) esthetic treatment needs of both the intervention and non intervention group who were exposed only to the regular traditional didactic teaching [13, 14]. The development and implementation of the study also used Miller's pyramid of clinical competence [15]. Miller's pyramid is a useful model to guide

Table 1 Study description with sequence of actions

Instructional event	Description	Content	Domain	Duration
Activation	Preparation for learning	Recall, relate describe from the past, students experience of esthetic treatments and needs	Cognitive 'knows'	1 h
	Assignment-1	Students were provided with reading material showing evidence of esthetic principles in practice	Cognitive 'knows'	
Demonstration	Group interaction	Overview of the assessment-1.Power point presentations for topics related to dental esthetics by four group representatives and feedback by the peers	Cognitive and affective 'knows how'	1.5 h
	Assignment-2	Each student interviewed a member of the public to obtain information about what people liked and/or disliked about the esthetic component of their anterior restorations and summarize it for the group the next day		
Application		Overview of the assignment-2, reflective exercise by the four groups facilitated by the trainer and feedback	Cognitive affective and psychomotor 'shows how'	1.5 h
		Rating of 14 different esthetic discrepancies by each student		
	Assignment-3	Accessing and preparation for presentation of one literature article related to any esthetic discrepancy by each group		
Integration	Transfer of learning	Overview of the assignment-3, presentation of the literature article by the group representative facilitated by the trainer.	Cognitive and affective psychomotor 'does how'	1 h 30 min for each student
		Modified peer (simulated patient) assessment of esthetic dental treatment needs (instrument 2). Modified professional assessment using professional's assessment questionnaire (instrument 3)		

teaching and assessment in health professions education. The first two levels of the pyramid, "knows" and "knows how," focus on the students ability to describe their skills verbally rather than actually demonstrating them. The "shows how" level focuses on performance, and the "does" level is associated with direct observations of students performance with actual patients in clinical settings. The phases of instruction involved the students in four distinct phases of learning. The study description with the sequence of actions appears in Table 1.

At the end of the study the facilitator instructed each student to complete the group, self and peer assessments form [16] on a five point Likert scale as shown in Table 3. This document was used to assist the facilitator and the group in making an assessment of their work. The individual subjective assessments and comments were then tabulated and were discussed with the group. Data were analyzed with R version 3.1.0. All statistical testing was performed with $\alpha = 0.05$. With 40 students per group, detection of a 1-item difference in total score (number of esthetic features correctly identified as present or absent) with a standard deviation of one using a t test yields over 99 % power, and test of a regression coefficient for group in the presence of three other covariates (rater, group × - rater interaction, and total number of esthetic features present in the patient being examined) yields 94 % power. Of the 13 items (Table 2), seven of those items had

variability in the student ratings versus the expert ratings in both the intervention and control groups. Using these seven items receive operating characteristic (ROC) curves were constructed for the intervention and control groups, for each item, treating the experts as the gold standard. Figure 2 shows that the average ROC curve for intervention is strictly and significantly higher than the ROC curve for the control group, suggesting that the intervention group was not only more accurate overall but more likely to report a feature that was present and to report the lack of a feature that was absent. (This was general true for individual item curves, although the intervention group seemed to do particularly poorly on item Q13.)
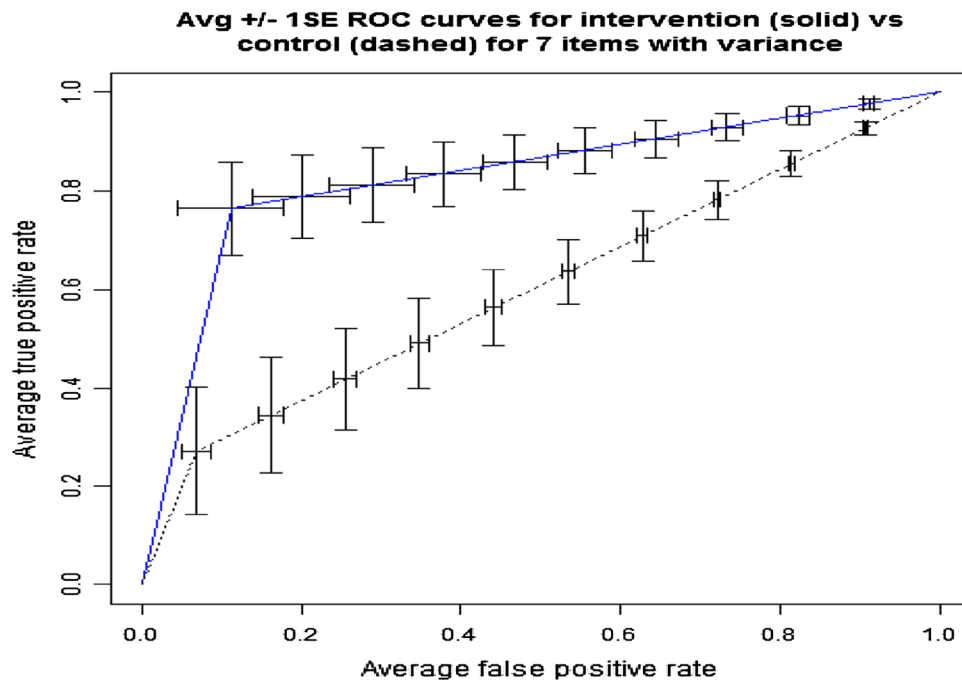
Prior to fitting the linear regression model, we computed the total number of esthetic problems found by the experts for each patient (student being examined by an expert), in order to control for the difference in difficulty between identifying features that are present and omitting features that are absent. The total number of esthetic problems was equally distributed in the control and intervention groups (Wilcoxon rank-sum $W = 728$, $p = 0.48$).

Results

The total number of items that each student got correct (that is, where their response matched the expert's), and

Table 2 Comparison of item of the peer evaluation questionnaire with each item in professional analysis

| Professional assessment | Responses of item with (students) | | | | | | Kappa statistics |
| | Intervention group | | | Non intervention group | | | |
Items	Students	% Agreement	Professional	Students	% Agreement	Professional	
Gingival height asymmetry	7	77.78	9	9	37.50	24	0.165
Discoloured gingival	1	100.00	1	0	0.00	2	0.5
Red and swollen gums	1	100.00	1	0	0.00	0	0
Crowded teeth	0	0.00	0	2	50.00	4	0
Rotated teeth	6	100.00	6	3	100.00	3	0
Spaced teeth	1	100.00	1	1	33.33	3	0.25
Occlusal wear	24	60.00	40	19	47.50	40	0.052
Discoloured teeth	1	100.00	1	0	0.00	0	0
Overcontoured restorations	2	100.00	2	2	50.00	1	0
Poorrestoration margins	3	75.00	4	2	33.33	6	0.182
Discoloured fixed restorations	0	0.00	0	1	100.00	1	0
Discoloured fillings	16	94.12	17	6	50.00	12	0.133

Fig. 2 Receive operating characteristic(ROC) curves for the intervention and control groups

fitted a linear regression model (including group, rater, group × rater interaction, and total number of esthetic problems in the patient). Intervention students had significantly more correct items than control ($p < 0.001$). There was no significant difference by rater ($p = 0.19$) or group × rater ($p = 0.48$). Figure 3 shows that on average, intervention students were about 89 % correct, and control students about 82 % correct.

The agreement between intervention and non intervention with respect to percentage of agreement between professional assessment and student's peer assessment for discoloured gingiva and occlusal wear found moderate and for all other items the agreement found to be poor as seen in Table 2. Feedback from students of the intervention group indicated a positive attitude to this mode of learning in terms of cognitive, affective and psychomotor skills. The majority of the dental students (85 %; $n = 34$) rated the study as well as group skills, learning skills, reasoning skills, feedback skills and group performance as four or five on a five point Likert scale as shown in Table 3. Most of the students 75 % felt that could do better in giving feedback.

Fig. 3 Group effect from the linear regression model predicting total number of correct items (student response matched the professional assessment)
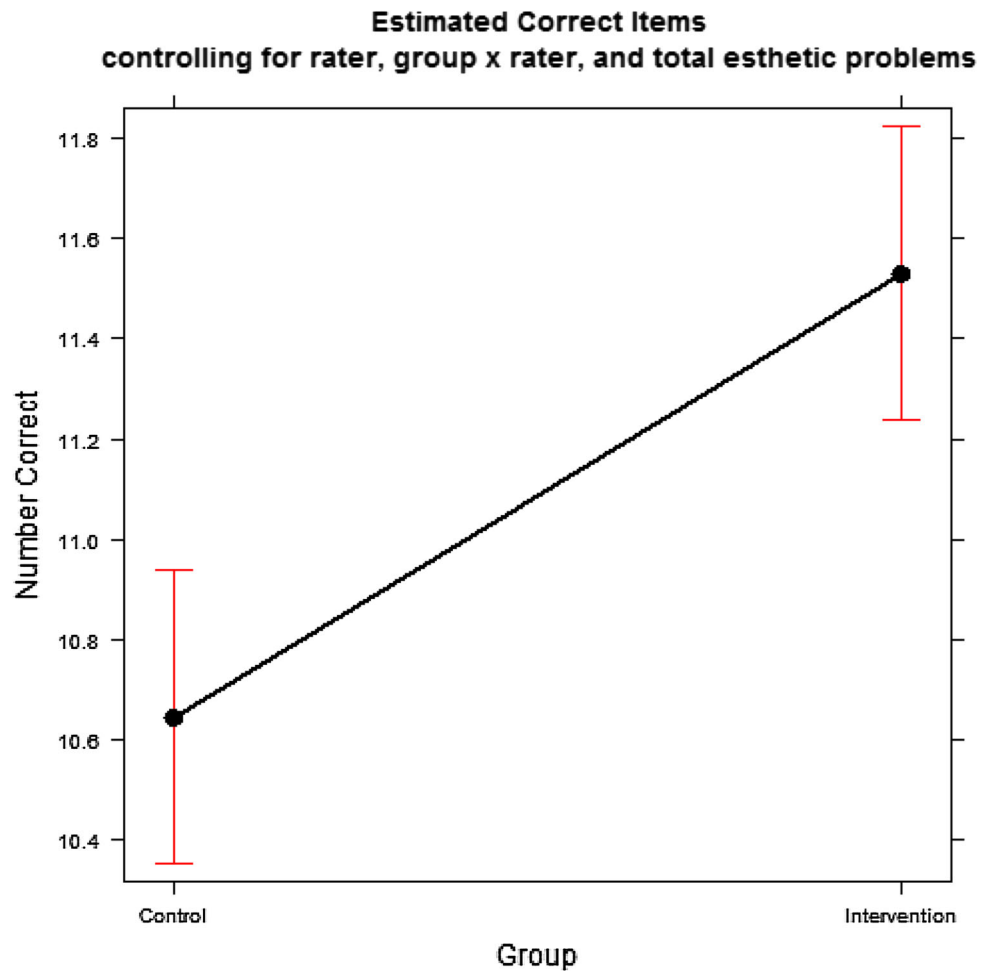

Table 3 Percentage of students in the intervention group ($n = 40$) who rated items 4 or 5 on 5 point scale

Group skills	
I actively participated in the work of the group showing a sensitivity to group needs as well as self needs and demonstrating respect for the aspirations of all members of the group	80 %
Learning skills	
I effectively identified group and individual learning needs and identified the appropriate learning resources.	86 %
Reasoning skills	
I demonstrated an ability to critically evaluate information, to synthesize and to critically appraise data.	89 %
Feedback skills	
I demonstrated an ability to provide constructive feedback to the group, promoting the group's ability to learn.	79 %
Overall I would rate our group performance in this case as	82 %
In terms of "Interest" I would rate this method of instruction as ($1 - 5$. $1 =$ very dull; $5 =$ highly interesting)	85 %

Scale of $1 - 5$ score ($1 =$ very poor; $5 =$ magnificent!)

Discussion

The results from this study show that the intervention group of undergraduate student's were more discerning than non

intervention group of undergraduate students to detect specific dental esthetic discrepancies emphasising the importance of instructional design framework in learning. These results are consistent with those from previous studies [16–19].

PBL is essentially a logical conclusion of student centered learning in that all learning is active, contextualised and small group based with a considerable amount of interpersonal communication. The principles of student centred learning are opposed to the traditional view of education which emphasises the role of teacher as the provider with the student passively receiving, absorbing and being moulded by knowledge. In terms of overall curriculum student centered learning implies a new way teaching and learning for both teachers and students. For teachers it may involve giving up power and authority and becoming a facilitator of learning. For students it means accepting responsibility and actively participating in learning giving up passivity and dependence. For both it involves collaboration and communication [18].

The conceptual framework for the first principles of instruction implemented in this study relates to problem-centered instruction. The authors of most instructional design theories would agree that these principles are necessary for effective and efficient instruction [12]. In our study effective learning environment was created with, the four distinct phases of learning that are problem centered [12] and Miller's pyramid of clinical competence [15].

Majority of the students participating in problem based learning tutorial sessions demonstrate knowledge acquisition, problem solving and analytical thinking skills. A PBL enhanced curriculum illustrates enhanced skill development pivotal in educating independent critical thinkers and more objective in allowing tutors to assess these skills [18]. When the aim is to help students to learn, teaching has to be considered as a series of activities that stimulate, facilitate, and guide the learning process [20, 21]. The PBL process helps students develop deeper understanding than possible in lectures and also stimulates the development of clinical reasoning and critical appraisal skills. When the concepts and format of PBL become well accepted among the whole faculty, the application of PBL in subsequent years will promote their own students's self efficacy in this teaching/learning method and enhance students ability to solve more complex problems in the future [17]. The USC dental students working in the PBL curriculum have attained a high level of achievement on U.S. National Dental Boards (Part I) examinations, significantly superior to their peers working in a traditional lecture-based curriculum [16]. Practicing a student centred approach in teaching and learning will lead to a better agreement in aesthetic treatment planning between the professionals and students, therefore establishing a positive impact on patient care and patient satisfaction. Our study was a preliminary attempt to explore the possibilities of introducing a student centered approach in assessment of dental treatment needs by the students.

In our study, students worked in groups. Through PBL and group discussions, students were allowed more time for self directed learning and brainstorming with teachers and classmates. Group work has been shown to enhance retention of knowledge and skills. Small groups help in filling gaps in the knowledge and skills of group members. They can also use a learner-centered process with less didactic teaching. The individual subjective assessments and comments discussed with the group was found helpful in prompting the group to consider its collective work and the contributions of each individual. In addition, this process was helpful in revealing any interpersonal problems that might be inhibiting the group dynamics [22, 16].

The data obtained out of the student's assessment focussed on overall peer evaluation of smile appearance and dental treatment needs. Few studies have evaluated the perception of dentists and lay people to altered dental esthetics [3] and studies have compared group perception of common anterior esthetic discrepancies [23, 24]. Computer-aided image manipulation shows promise as a method for investigating the significance of dental-related beliefs, especially those relating to esthetics, in different population groups. A key element in the use of PBL in the clinical areas is to establish the sequential clinical achievements for the student groups. In our study the groups of students were linked to particular levels of clinical competency [15] and the learning objectives in the problems were established to achieve this competency that gradually introduces the student to patient care. It is evident in this study that the ranking of the least noticeable dental features like gingival height asymmetry, occlusal wear, poor restoration margins, overcontoured restoration differed significantly with the intervention and non intervention group. The present study has also shown that the intervention group recognised specific dental esthetic discrepancies more readily than non intervention group.

Strategies to enhance learning in the PBL environment include time allocation for self-study, availability of resource materials and use of appropriate assessment methods. Problems that remain to be resolved include the choice of appropriate outcome assessment measures to evaluate the effectiveness of PBL as a mode of.learning in undergraduate dental education. In our study the need for esthetic dental treatment has been evaluated in a subjective and a professional (objective) manner in this study using two special questionnaires. Modified questionnaires used in this study were used to highlight the discrepancies between students and dentists perceptions of esthetic needs [14]. Intervention group were able to detect discrepancies and showed significant agreement with the professional assessment. The students rated the method favorably and they considered it enabled them to demonstrate their competences.

Many studies in the literature have reported discrepancy between the patient's and dentist's perception of dentofacial esthetics. Investigation of lay people's self-perception of dental esthetics has focused largely on gross esthetic

discrepancies related to debilitating malocclusions. Only a few studies determine the lay person's and dental professional's perception of minor variations in anterior tooth size and alignment as well as their relation to the surrounding soft tissues. However, no studies have evaluated anterior dental esthetics by investigating dental student's assessment of graduated degrees of abnormality and their agreement with a professional assessment by using a student centered approach of learning. Multiple opportunities to observe and practice with feedback may be required for students to apply the learning and retain the skills needed to manage the full scope of dental practice. However, implementation of the first principles of instruction problem in the available resources setting, did improve the competence of the students to effectively assess the dental esthetic treatment needs. This study may serve as a model for other Indian dental schools.

Conclusion

- The results of this study have shown a significant difference between intervention and non intervention group of undergraduate students in the rating of esthetic discrepancies.
- Intervention group of undergraduate student's were more discerning than non intervention group of undergraduate students to detect specific dental esthetic discrepancies.
- The relative agreement between intervention group of undergraduate students and the professional assessment of esthetic treatment need shows the importance of intervention of Merrill's first principles of instruction in learning, therefore indicating a positive impact on successful esthetic treatment for patients.
- When students err, it was more often in failing to notice a flaw that the experts see than in noticing a flaw that the experts don't.
- The intervention group made fewer of either kind of error than the control group. The intervention group's performance, though not perfect, was on average significantly closer to expert performance than the control group.

References

1. Carlsson GE, Wagner IV, Odman P, Ekstrand K, MacEntee M, Marinello C, Nanami T, Ow RK, Sato H, Speer C, Strub JR, Watanabe T (1998) An international comparative multicenter study of assessment of dental appearance using computer-aided image manipulation. Int J Prosthodont 11(3):246–254
2. Goldstein RE (1969) Study of need for esthetics in dentistry. J Prosthet Dent. 21(6):589–598
3. Kokich VO Jr, Kiyak HA, Shapiro PA (1999) Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Dent. 11(6):311–324
4. Lloyd PM (1994) Fixed prosthodontics and esthetic considerations for the older adult. J Prosthet Dent 72(5):525–531
5. Dennick RG, Exley K (1997) Tomorrow's doctors today: innovations in medical teaching and learning—responding to the challenge of tomorrow's doctors. Biochem Educ 25:6–11
6. Bransford JD, Brown AL, Cocking RR, Donovan MS, Pellegrino JW (2003) How People learn brain, mind, experience, and school, expanded edn. Natl Acad, Washington, DC
7. Gillian HR, Elizabeth T (2003) Providing support for problem-based learning: The Manchester experience. Eur J Dent Educ 7:3–12
8. Fincham AG, Shuler CF (2001) The changing face of dental education: the impact of PBL. J Dent Educ 65(5):406–421
9. Morales-Mann ET, Kaitell CA (2001) Problem-based learning in a new Canadian curriculum. J Adv Nurs. 33(1):13–19
10. Christopher DF, Harte K, George CF (2002) The implementation of tomorrow's doctors. Med Educ 36(3):282–288
11. Kinkade S (2005) A snapshot of the status of problem-based learning in U.S. medical schools, 2003 − 04. Acad Med 80(3):300–301
12. David Merrill M (2001) First Principles of Instruction. ETR&D, vol 50, no 3. ISSN 1042–1629:43–59
13. Brisman AS (1980) Esthetics: a comparison of dentist's and patient's concepts. J Am Dent Assoc 100(3):345–352
14. Tortopidis D, Hatzikyriakos A, Kokoti M et al (2007) Evaluation of the relationship between subjects perception and professional assessment of esthetic treatment needs. J Esthet Restor Dent 19:154–163
15. Downing SM, Yudkowsky R (2009) Assessment in health professions education. Routledge, New York
16. Fincham AG, Shuler CF (2001) The changing face of dental education: the impact of PBL. J Dent Educ 65(5):406–421
17. Chakravarthi S, Haleagrahara N (2010) Implementation of PBL curriculum involving multiple disciplines in undergraduate medical education programme. Int Educ Stud 3(1):165–168
18. Allareddy V, Havens AM, Howell TH, Karim bux NY (2000) Evaluation of a new assessment tool in problem-based learning tutorials in dental education. J Dent Educ 75(5):665–671
19. Koh CG, Khoo EH, Wong LM, Koh D (2008) The effects of problem based learning during medical school on physician competency: a systematic review. CMAJ 178(1):34–41
20. Kersten HW (1997) The enhancement of learning by teaching. Eur J Dent Educ 1(4):149–152
21. Dennick RG, Exley K (1997) Tomorrow's doctors today: Innovations in medical teaching and learning—responding to the challenge of tomorrow's doctors. Biochem Educ 25:6–11
22. Regan-Smith M, Young WW, Keller AM (2002) An efficient and effective teaching model for ambulatory education. Acad Med 77(7):593–599
23. Thomas M, Reddy R, Reddy BJ (2011) Perception differences of altered dental esthetics by dental professionals and laypersons. Indian J Dent Res 22(2):242–247
24. Kokich VO, Kokich VG, Kiyak HA (2006) Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. Am J Orthod Dentofacial Orthop 130(2):141–151