IMPACT OF AN INNOVATIVE APPROACH OF TEACHING SCIENCE OF DENTAL MATERIALS ON THE LEARNING EXPERIENCES OF UNDERGRADUATE STUDENTS

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ABSTRACT

Objective: To investigate the impact of an innovative approach for teaching Science of Dental Materials on the learning experiences of undergraduate dental students by assessing their performance at the end of the academic year.

Study Design: Action research with a mixed method approach.

Place and Duration of Study: The study was conducted at Islamabad Medical & Dental College (Dental Section). The duration of study was three and a half years from Jan 2011 to Apr 2013.

Material and Methods: The entire first year of session 2011 (groups A, n=50) and session 2012 (group B, n=51) comprised the study's sample, using non-probability convenience sampling technique. Group A was taught science of dental materials traditionally while innovation by adding clinical rotations in the curriculum was done for group B. At the end of the academic year assessments scores were compared by independent t-test and assessment outcome (pass/fail) was compared by chi-square test. When these sessions were in their final year a focus group discussion amongst the groups and senior faculty were done.

Results: Assessment scores showed no significant difference. Assessment outcome of practical's showed significant difference (p=0.004) relating to improvement in group B. Focus group discussion showed group B students relating to dental materials in clinical context with a much better understanding. Faculty found it to be a pleasant experience however more resource intensive.

Conclusion: Clinical correlation of dental materials showed significant improvement in first year students due to an innovative approach by the help of the new rotational plan in clinics.

Keywords: Assessment, Clinical rotations, Dental education, Integration, Science of dental materials.

INTRODUCTION

Basic science subjects provide the foundations of education in healthcare curricula. However, teaching basic science subjects to undergraduate students remains a challenge. Contemporary trends in healthcare education support horizontal and vertical integration to break the barriers between different topic areas with the aim to enhance the relevance and application of basic science in clinical practice[1].

Traditionally science of dental materials (SDM) has been taught in year 1 of the Bachelor of Dental Surgery (BDS) curricula in Pakistani universities. Following establishment of the University of Health Sciences, Lahore, Pakistan in 2003, the undergraduate dental curriculum was revised for the first time in several decades. SDM was moved to year 2 of the BDS curriculum while Oral Biology was moved from year 2 to Year one[2]. The aim of these changes was to enhance integration of Oral Biology with Anatomy and Physiology. Similarly, it was considered that it may be more appropriate to teach SDM in year 2 when the students have gained an elementary knowledge of clinical dental practice to facilitate a better understanding of the application of dental materials in clinical environments. This step was also taken by some of the other Universities. Most other universities sub-sequently followed a similar approach.

SDM is a core subject in undergraduate dental curriculum and teaching should equip the dental students with the safe and effective use of a broad range of dental materials in clinical den-

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tal practice. However, like most basic subjects, effective integration of SDM into clinical practice in the undergraduate curriculum remains a huge challenge[3]. Given the clinical training of dental undergraduates only after completion of the first two years, the learning experience of students in SDM is largely limited to factual learning with limited understanding of clinical relevance of the topics.

Dentistry is a demanding profession and undergraduate students perform irreversible clinical procedures on patients during their education and training. Therefore, effective teaching is critical for student learning, and public safety[4-6]. Undergraduate dental education and training is provided in a multitude of settings including lectures, workshops, small group teaching, simulated dental learning environments, laboratory and clinical education facilities[7]. Evidence from the literature suggests that rotations aimed at application of basic science topics in clinical environments and strategies aimed at enhancing students' learning experiences should be based on an appropriate methodology to investigate and assess the impact of innovative approaches[8-10]. It is also established that effectiveness of new approaches in teaching and learning may need to be evaluated using appropriate assessments of students. Performance of students in assessments may be helpful to measure the impact of innovative teaching methods[10]. Assessment promotes learning and a two-way feedback between teachers and students may provide useful insights into the teaching approaches and inform the curriculum development.

The aim of this mixed method study was to investigate the impact of an innovative integrated approach for teaching SDM on the learning experiences of undergraduate dental students and explore perceptions of students and faculty members about their experiences of the modified curriculum.

MATERIAL AND METHODS

This research was based on a mixed methods action research design. Ethical approval for the study was obtained from the Institutional Review Board (IRB). The sample size consisted of 101 participants selected from two successive similarities based comparable cohorts of first year BDS students enrolled in 2011 and 2012 from Islamabad Medical & Dental College (Dental Section), Bahria University, from Jan 2011 to Apr 2013. Both cohorts studied science of dental materials in first year BDS.

The 2011 cohort (group A) included 50 students who were taught science of dental materials according to the traditional curriculum. The 2012 cohort (group B) consisted of 51 students who were taught science of dental materials with a modified teaching approach which included rotational placement on clinics along with traditional teaching in classroom settings. The admission criteria, total hours of instruction, tutors and assessment were similar for both cohorts.

Quantitative data collection included University assessment scores (first year SDM professional examination marks) of both cohorts. The assessment scores were compared by independent t-test and assessment outcome (Pass/Fail) of SDM was compared by Chi-square test using SPSS version 16. A p-value ≤ 0.05 was considered to be a significant value. The methods for this study are depicted in fig-1.

Qualitative methods based on focus groups were used to evaluate the impact of learning experience of the students. Focus groups of 15 students was randomly selected by lottery method from each cohort when they were in their final year. The participants were provided with an information sheet and consent was obtained prior to participation. Each focus group lasted for approximately one hour and minutes were taken by a scribe. Participants were assigned seat numbers hence to ensure anonymity, their names did not show in the transcription. A third focus group discussion of five faculty members involved in the teaching, training and examination assessments of both the research classes was conducted. Data from focus group was tran-

scribed and a thematic analysis was carried out by identifying major ideas being discussed in the focus group discussion and counting words representing those ideas through a constant iterative approach. Similar ideas were categorized under one theme and the title of the theme reflecting the gist was selected. Comments verbatim from the summaries under each theme were selected for display in the thematic analysis matrix to demonstrate plausibility of inferences drawn. Conclusions drawn were further put to the test of plausibility, sturdiness and conformability through member checking by co-authors. Triangulation of quantitative and qualitative data was done to additionally validate the conclusion.

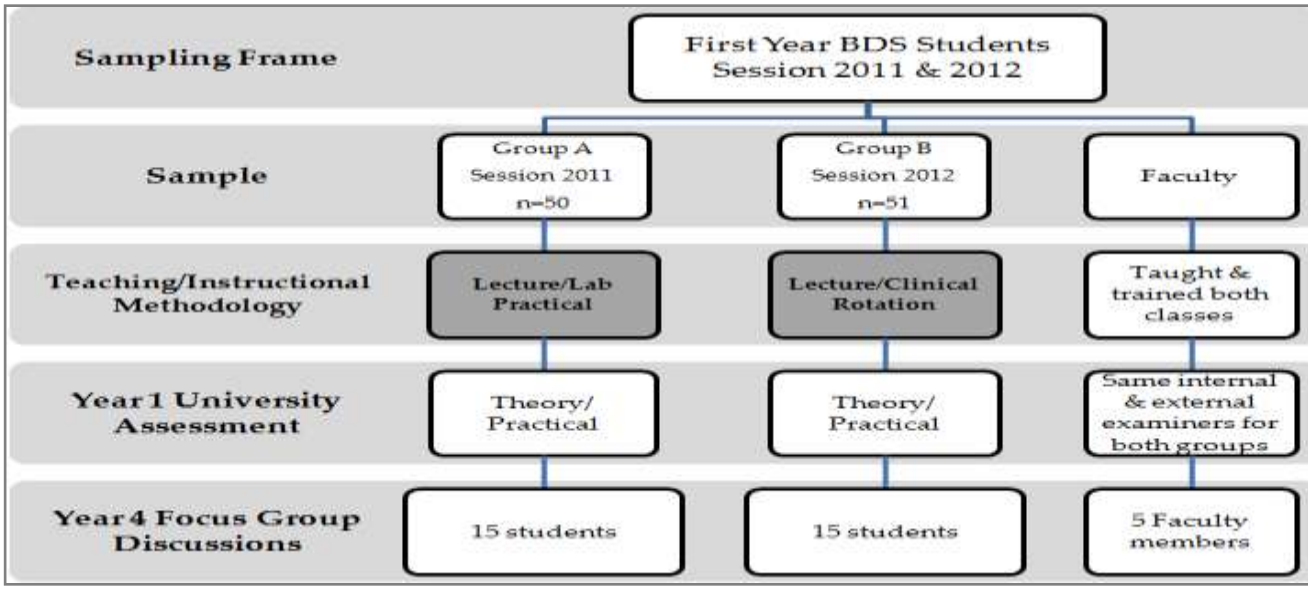

Figure-1: Schematic presentation of methodology.

RESULTS

The sample size consisted of 101 students. Three students in group A dropped out and were unable to take the University assessment, therefore data of forty-seven students was entered for group A. There were eight male (17%) and 39 female (83%) students in group A (Age range 17-22 years, Mean age 18.83 ± 1.18). Groups B had 20 male (39%) and 31 female (61%) students (age range 17-23 years, Mean age 19.21 ± 1.28).

Assessment scores of both groups were compared by independent t-test with a total mean score of group A to be negligibly higher than group B. Mean score of theory paper alone was also higher for group A while mean score of practical assessment was higher for group B (table-I).

Assessment outcome was compared by Chi-square test showing significance (p=0.004) in the practical results where seven students had failed in group A while all students had passed in group B (table-II).

Fifteen students from group A and group B participated in the focus groups in year 4 of the BDS program along with senior members of the faculty involved in the teaching of SDM (N=5).

The results of the focus groups showed higher satisfaction levels and more positive perceptions in group B (Comment 2, 4 & 5, table-III). The participants from group B reported higher motivation levels and drive for learning the subject of dental materials compared to group A. There was unanimity amongst the participants that clinical rotations enhanced their understanding of the subject (Comments 11, table-III). Opportunities to observe the application of dental materials in clinical settings provided a context and relevance for their learning and there was less reliance on rote learning. Handling

dental materials and observing them being used on patients also allowed them to approach their practical work in the laboratory with a greater degree of confidence (Comment 12, table-III). Both groups thought that the subject was dry, and it was the information load in the subject that was challenging in year 1 (Comments 1-5, table-III). Faculty found it to be a nice experience. However, it was more resource-intensive requiring faculty training and time-commitment (Comments 23-30, table-III). Faculty thought that it helped students attempt practical assessment with much more ease and better understanding (Comment 13 & 14, table-III).

Table-I: Comparison of assessment scores between groups.

	Group A (n=47) Mean ± SD	Group B (n=51) Mean ± SD	*p*-value (Independent t-test)
Total Scores (200 Marks)	130.02 ± 24.22	129.29 ± 18.62	0.86
Theory Scores (100 Marks)	65.26 ± 13.18	61.80 ± 11.47	0.16
Practical Scores (100 Marks)	65.13 ± 12.70	67.49 ± 8.17	0.27

Table-II: Comparison of assessment outcome between groups.

		Group A (n=47)	Group B (n=51)	*p*-value (Chi square test)
Total (Theory + Practical)	Pass	38	46	0.19
	Fail	9	5	
Theory (Pass = 50/100)	Pass	41	46	0.64
	Fail	6	5	
Practical (Pass = 50/100)	Pass	40	50	0.004
	Fail	7	0	

DISCUSSION

A major challenge in basic science subjects in dentistry is the application of knowledge from the classroom to clinical application. To bridge this gap, Persky *et al*[11] aimed to enhance students' learning experience in a foundation course in pharmacology by teaching the subject in a clinical context and using formative assessment. They reported teaching pharmacology in a clinical context yielded better long-term retention than teaching with a non-clinical focus. Their findings relate to the findings of the present study where teaching basic dental subject in a clinical context improved mean practical scores (67.49 ± 8.17) and significantly improving assessment outcome (p=0.004) (Comments 11 & 14, table-III).

Samuelson *et al*[12] reported a clear preference of case-based learning to lecture based instruction, and the findings suggested educational benefits associated with case-based learning. Their results suggest the introduction and further testing of case-based learning in the preclinical dental curriculum, anticipating future benefits during clinical training, which is in accord with the findings of our study where the group B students significantly benefited in the practical assessment outcome (table-II) (Comment 12-14, table-III).

A mediation regression analysis revealed that Integrated instruction was associated with improved conceptual (p<0.001), but not procedural knowledge test scores (p-value 0.11), suggesting that integrated instruction may improve students' skill retention and transfer through gains in conceptual knowledge[13]. These results are supportive of the findings in our study indicating no significant improvement in scores of theory while there was a statistically

significant improvement in assessment outcome of practical (*p*-value 0.004) after learning through integrated instruction.

It is generally considered that dental students must acquire knowledge, skill and attitudes but there are controversies regarding the most

Table-III: Thematic analysis of focus group discussion with Group A, B & faculty.

Themes	Word Frequency Count	Comments Verbatim
Subject Enjoyment	Boring (8) Dry (5) Dull (2) Rote learning (2)	Group A 1. "The subject was dry, boring and involved a lot of rote learning."
		Group B 2. "Lectures seemed stretched and tiring. The clinical implications and rotations made it very interesting. Actually handling the materials in clinics was fun. Kept the picture of the materials we used in clinics in our minds. After handling the material in clinics it was easier for us to comprehend from the books."
Teaching	Comprehend (2) Clinical relevance (19) Long (5) Understand (11)	Group A 3. "Lectures were too long. It's hard to grasp the subject from long lectures.
		Group B 4. "Lectures seemed stretched and tiring. The clinical implications and rotations made it very interesting. Actually handling the materials in clinics was fun. Kept the picture of the materials we used in clinics in our minds." 5. "After handling the material in clinics it was easier for us to comprehend from the books."
		Faculty 6. "Group A students who were good responded very well. Students who were average or below were lost." 7. "Clinical relevance of materials for all Group A students was hard to comprehend although it was taught in lectures and re emphasized during practical's." 8. "It was a nice experience especially as our Group B students showed great improvement in clinical correlation of materials."
Clinical Correlation & Performance	Correlate (7) Difficult (8) Materials (40) Practical(8) Exam (5) Answer (12) Questions (9) OSPE (2)	Group A 9. "We were not able to correlate its use in dentistry. We were asked clinical questions about materials in our viva which we could not answer." 10. "I was asked to mix alginate material in OSPE stations in the final exam where as in our practical's we only mixed hard and soft plaster."
		Group B 11. "The materials that we had handled in the clinics were easy for us to correlate clinically in the exam." 12. "I was very confident answering questions relating to clinical correlation of dental materials."
		Faculty 13. "Group A students found it difficult to manipulate materials in exams and correlate them clinically." 14. "Group B students correlated materials which they had handled in clinics in a much better way."
Ideal Teaching & subject scheduling	Dynamic (2) Videos (3) Relevance (3) Workshop (3) First Year (12) Final Year (3) Integrate (10) Improve (11)	Group A 15. "Lectures should be dynamic. Videos should be shown. Practical's should have relevance with clinical scenario." 16. "SDM should not be a subject in 1st Year BDS. It should be taught in subsequent years. Workshops should be conducted in final year to refresh materials."
		Group B 17. "Instructions in 1st year were good. But after that till final year we had minimal interaction with materials." 18. "We feel it is not a 1st year BDS subject. It should be taught in subjects where those materials are applicable."
		Faculty 19. "Teaching improved during integration. We feel regular reports and audits from medical education department can help further improve and modify teaching methodologies." 20. "Teaching environment must improve for better teaching." 21. "SDM should not be a 1st year BDS subject. It needs integration into different years." 22. "It should be taught either in 2nd or 3rd year BDS."
Barriers for integration	Work load (4) Lectures (5) Implementation (3) Training (5) Change (3) Space (3) Human resource (3) Cost (2)	Faculty 23. "Work load increased with integration for clinical departments. 24. "Order of lectures and practical's or clinics needed more coordination." 25. "Concepts taught in clinics had to be similar in lectures as in integrated larger number of faculty members were involved." 26. "For integration to clinics space was less. Departments get cramped up when 1st year students rotate." 27. "Human resource remained the same. With integrated teaching HR should be increased." 28. "Students waste materials during handling in clinics. Departmental cost of materials increased in integrated." 29. "Administration has to be in line with the change." 30. "Changing anything should include training of the new methodology before implementation."

effective way of teaching basic science subjects. Currently, in Pakistan the basic and clinical sciences are taught separately and efforts are being made to integrate both basic and clinical sciences to reach a more effective outcome. On a sample of 51 students Baghdady *et al* compared the diagnostic accuracy of students who were taught basic sciences segregated and integrated curricula and concluded that teaching basic sciences integrated with clinical subjects produces higher diagnostic accuracy in novices[14]. The results and conclusions were similar to those of the current study where integrated instruction produced a better outcome in the practical assessment (table-II).

In our study, it was interesting to note that there was no impact on the assessment scores. Mean theory assessment scores of the traditional group (group A) were higher (65.26 ± 13.18) and there was no statistical difference in the mean practical scores of both groups (*p*-value 0.27). However, in general more students passed the practical in group B which rotated to clinics (*p*-value 0.004) suggesting that clinical rotations worked well for average and borderline students. It has also been reported that students perceived and understood dental materials better, co-related them clinically and found it interesting than the traditional lectures[15].

With the evolution of dentistry new trends have sprung up. One of those recent trends are the integration of basic dental sciences with inter-disciplinary implementation in clinical settings[16]. Our focus group findings (Comments 15-22, table-III) strongly relate to recent trends. Coelho and Moles[17] evaluated student perception on spiral curriculum with a conclusion that it provides opportunity to revisit and consolidate learning. The present study depicts a similar trend of both students and faculty towards the fact that "SDM should not be a 1st year BDS subject. It needs integration into different years"(Comment 21, table-III).

Being a single cohort from one institution was the main limitation of this study. Recommendation in future is to involve more institutions with a larger sample of students and faculty.

CONCLUSION

Clinical correlation of dental materials showed significant improvement in first year students due to an innovative approach by the help of the new rotational plan in clinics.

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CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

REFERENCES

1. Weatherall D. Science and medical education: Is it time to revisit Flexner? Med Educ 2011; 45(1): 44–50.
2. University health sciences. Revised Curriculum of BDS - 2003. Second professional BDS. Syllabus & courses; 2003 [www.uhs.edu.pk]. c2003 [updated 2003; cited 2018]. Available from www.uhs.edu.pk/downloads/curr_bds_prof2.pdf
3. Kulasegaram KM, Martimianakis MA, Mylopoulos M, Whitehead CR, Woods NN. Cognition before curriculum: Rethinking the integration of basic science and clinical learning. Acad Med 2013; 88(10): 1578–85.
4. Chan MWC. The future of clinician-scientists in Canada. J Can Dent Assoc 2004; 70(6): 379–81.
5. Dable RA, Pawar BR, Gade JR, Anandan PM, Nazirkar GS, Karani JT. Student apathy for classroom learning and need of repositioning in present andragogy in Indian dental schools. BMC Medical Education 2012; 12(1): 118.
6. Myers B. Beliefs of dental faculty and students about effective clinical teaching behaviors. J Dent Educ 1977; 41(2): 68-76.
7. Kernan WN, Lee MY, Stone SL, Freudigman KA, O'Connor PG. Effective teaching for preceptors of ambulatory care: A survey of medical students. Am J Med 2000; 108(6): 499-502.
8. Miyoshi T, Hobo K, Sunaga M, Kinoshita A. Effects of an interactive simulation material for clinical dentistry on knowledge acquisition. J Med Dental Sci 2017; 64(2-3): 35-42.
9. Zhijie Y. Implementation of teaching strategies in a medical physiology curriculum: A shift to students centred learning. China Papers 2003; 74-7.
10. Susan P, Doug W. A comparison of assessment practices and their effects on learning and motivation in a student-centered learning environment. J Educ Multimed Hypermed 2004; 13(3): 283-307.
11. Persky AM, Wells MA, Sanders KA, Fiordalisi J, Downey C, Anksorus HN. Improving Dental Students' Long-Term Retention of Pharmacy Knowledge with "Medication Minutes". J Dent Educ 2017; 81(9): 1077-84.
12. Samuelson DB, Divaris K, De Kok IJ. Benefits of Case-Based versus Traditional Lecture-Based Instruction in a Preclinical

Removable Prosthodontics Course. J Dent Educ 2017; 8(4): 387-94.
13. Cheung JJH, Kulasegaram KM, Woods NN, Moulton C, Ringsted CV, Brydges R. Knowing How and Knowing Why: Testing the effect of instruction designed for cognitive integration on procedural skills transfer. Advances Health Sciences Edu 2018; 23(1): 61-74.
14. Baghdady MT, Carnahan H, Lam EW, Woods NN. Integration of basic sciences and clinical sciences in oral radiology education for dental students. J Dent Educ 2013; 77(6): 757–63.
15. Gali S, Shetty V, Murthy NS, Marimuthu P. Bridging the gap in 1st year dental material curriculum: A 3 year randomized cross over trial. J Indian Prosthodont Soc 2015; 15(3): 244-49.
16. Hammad HG, Hamed MS. Integration of dental education for knowledge retention: Review of literature. Indian J Multidiscip Dent 2016; 6(1): 25-7.
17. Coelho CS, Moles DR. Student perceptions of a spiral curriculum. Eur J Dent Educ 2016; 20(3): 161-6.
18. Zary N, Johnson G, Bobery J. Development, implementation and pilot evatluation of a web based virtual patient care simultation environment – WEB-SP: BMC Medical Education 2006; 6(1): 10.

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