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STUDENTS' PERCEPTION OF PROBLEM SOLVING EXERCISE IN RADIOLOGY EDUCATION FOR UNDERGRADUATES

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ABSTRACT

Objective: Teaching of radiology has followed a didactic approach in most medical colleges. Our study aims to assess students' perception of the efficacy of problem solving exercise which was introduced as an adjunct to the conventional curriculum. **Materials and Methods:** The students belonging to the MBBS batch 2014-15, (N=120), were subjected to a new method of teaching with Problem Solving Exercise and integrated teaching in collaboration with other departments. Students' perception regarding the new method was assessed through a specially designed Likert Scale combined with teachers' own reflection. **Results:** The students either strongly agreed or agreed with all 25 items that described satisfying learning experience provided through PSEs. Combined with the evidence from teacher's own reflection it is evident that the use of PSE is much sought out intervention for teaching radiology. **Conclusion:** Innovative teaching methods that involve integrated teaching and use of PSEs are perceived as effective teaching methods by the undergraduates in learning radiology.

KEYWORDS: Undergraduate medical education, teaching of radiology, Problem Solving Exercise, Picture Archiving Communicating System, integrated teaching.

INTRODUCTION

Medical education in India is at cross roads. While India is one of the largest contributors to the medical manpower in the world, the quality of medical education is a matter of constant debate. Several reports have pointed out deficiencies such as the curriculum being overloaded with facts and information with less emphasis on development of higher cognitive abilities, skills, and attitudes, besides shortage of teachers, predominance of didactic instruction and faulty assessment.[1,2,3,4,5,6]

Medical Council of India (MCI), which prescribes undergraduate curriculum has recognized some of these limitations. It recommends that 'every attempt should be made to de-emphasize compartmentalization of disciplines so as to achieve both horizontal and vertical integration in different phases'.[7] However, the question still remains – are we moving towards this goal?

The teaching of radiology in undergraduate medical education is a matter of concern. No doubt radiology has seen unprecedented growth as a specialty as witnessed by manifold increase in the investigations largely due to the revolutionary progress in the field of imaging techniques, which made the diagnosis, easier, faster and more accurate. However, teaching of radiology has not received as much attention as it deserves. This is evident from the deliberations of European Society of Radiology (ESR) which conducted a comprehensive survey covering 430 teaching hospitals from 26 countries and came out with a white paper on radiology training.[8] The Society noted that radiology teaching in Europe varied from one medical school to another depending upon the hospital patient load, the availability of competent faculty and their dedicated time given for teaching. The use of Problem Based Learning (PBL), or its nearest ally Case Based Leaning (CBL), incorporation of digital imaging and Picture Archiving Communication System (PACS) were used in varying degrees within the format of radiology as independent subject (classical model), integrated with clinical teaching (modular approach) or a combination of core and optional modules (hybrid approach). Compared with this, the teaching of radiology in the Indian context takes place within the framework of

curriculum prescribed by the MCI (classical model) with didactic lectures supplemented with brief posting of about two weeks in radiology.

Keeping in mind these developments and specific needs of our teaching hospital situated in South India, we focused on undergraduate radiology training, one of the authors (CS) being a faculty member of radiology. Our study covered one full batch of undergraduate students admitted during the year 2014-15 (N=120) who entered 5th semester studies.

MATERIALS AND METHODS

The study protocol was got approved by the Institute Ethics Committee. Informed consent was obtained from all students recruited for the study. (N= 120)

Ten topics covered in the radiology curriculum were divided into two parts: Part I comprising Women's imaging, Radiation hazards, Respiratory system including mediastinum, and cardiovascular system, was taught by innovative method (Problem Solving Exercises with PACS). Part II comprising Skeletal trauma, Gastrointestinal system, Neuroradiology, Genitourinary system and Head injury was taught by traditional teaching-learning method.

Our study included two components. The first component was to observe and compare the performance of students after subjecting them to innovative methods vis-à-vis, conventional teaching, in the domain of knowledge and interpretive skills. We found a significant improvement in students' knowledge and interpretive skills, when taught by innovative method which we have reported elsewhere. In the second part of the study, we focused on students' perception of the experience of problem solving exercises and the integrated teaching.

Though the literature in medical education lists several interactive methods depending upon the size of the class room or domain involved in learning,[9] we picked up Problem Solving Exercises (PSEs), Case Based Learning (CBL), and integrated teaching.

Cases were drawn from the PACS collections of the department of radiology consisting of images, case histories with appropriate clinical findings, and lab reports obtained from the case records.

Students were allotted the cases in advance on the previous day. They were encouraged to discuss with the peers and read up relevant literature.

During the teaching session, a conversation was initiated by the radiologist, followed by the subject specialist, by asking questions such as, 'What is the possible diagnosis/differentials? Do you need any other investigation? Why do you think so?'

If a student came up with correct reason, the test result (lab result/ result of other modality of choice like USG/CT) was provided. If the diagnosis was not correct, then the students were asked to discuss other options. Once the correct diagnosis was clinched, students' answer was reinforced with an applause. This strategy helped in maintaining a high level of interaction and motivation among students.

Then the discussion was extended to the treatment plan and a brief discussion on the preventive aspects. While the teachers from Pathology and Forensic Medicine joined in facilitating horizontal integration, those drawn from medicine, surgery, gynecology, ENT, pediatrics and orthopedics facilitated clinical integration (vertical integration). When a case of pneumonia was put up for discussion, pathologist would explain gross pathology and histo-pathology of pneumonia. The clinician would discuss the signs and symptoms, besides treatment of pneumonia. The radiologist would discuss the radiological investigation and findings, thereby giving a holistic picture of pneumonia. This intervention was continued throughout one academic year.

Tool development and administration

In order to capture students' perception of the intervention, we listed various domains or attributes of successful learning experience, which formed the basis for developing statements for a five point Likert scale. This resulted in 12 domains encompassing four main areas, viz., the teacher attribute (e.g., friendliness and encouraging attitude), motivation created for learning, satisfaction with the intervention, and effectiveness of methods used during course of intervention. Five to six statements were written for each domain/attribute in the form of either positive or negative statement to capture the degree of agreement from 'Strongly agree' to 'strongly disagree'. The method of scoring used was to look for the counts in respect of each statement.

The scale was peer reviewed for its construction and content validity. Out of 35 items written initially, 10 items were eliminated for lack of content validity or flaw in construction. Thus, 25 items were retained for final administration. The various components of Likert scale and the item numbers which represent them are shown in Box 1.

Box 1. Components of Likert Scale and corresponding items in the Likert Scale

	Components	**Item numbers in the Likert Scale (Total)**
1	The teacher attribute	B1, B4, B14 (3)
2	Motivation derived for learning	B2, B22 (2)
3	Satisfaction with learning process:	

3 a)	Overall satisfaction	B3, B16, B19, B24 (4)
3 b)	Increase in reasoning skills	B10, B18, B23 (3)
3 c)	Enhancing clinical application	B11, B17, B20 (3)
3 d)	Facilitation of team work	B12 (1)
4	Method of teaching:	
4 a)	High interactivity	B6, B8, B13 (3)
4 b)	Use of multiple strategies	B5 (1)
4 c)	Linking new information with previous learning	B7 (1)
4 d)	Facilitating communication skills	B9, B15 (2)
4 e)	Making learning more meaningful	B21 (1)
4 f)	Facilitated integration	B25 (1)

The final Likert scale consisting of 25 items was administered to the students directly, and the scores, viz., actual counts are tabulated in Table 1.

Table 1: Table showing the number of responses showing the extent of agreement with the perceived advantage of various attributes of Problem Solving Exercises (N=120)

Sl.No	ATTRIBUTES	No. of items	The extent of Agreement or Disagreement (Counts) for each statement						
			Item no.	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	No Response
1	Teacher attribute	3	B1	2	0	9	14	95	0
			B4	0	0	3	10	107	0
			B14	73	34	4	0	9	0
2	Motivation for learning	2	B2	0	0	7	16	97	0
			B22	1	1	4	29	83	2
	Satisfaction with learning								
3	Overall satisfaction	4	B3	0	0	6	19	95	0
			B16	2	0	5	16	97	0
			B19	60	32	12	4	12	0
			B24	0	2	13	18	87	0
4	Increase in reasoning skills	4	B10	78	32	0	0	9	1
			B18	0	0	10	35	75	0
			B23	74	30	7	0	9	0
5	Application for clinical setting	3	B11	0	0	9	18	93	0
			B17	0	0	13	18	89	0
			B20	0	0	2	27	91	0
6	Team work	1	B12	0	0	3	26	91	0
	Method of teaching								
7	Use of multiple strategies	1	B5	0	4	2	24	90	0
8	High interactivity	3	B6	0	0	6	14	99	1
			B8	69	26	11	4	8	2
			B13	0	0	1	22	97	0
9	Linking information with previous experience	1	B7	0	0	10	14	96	0
10	Facilitating communication	2	B9	0	0	9	31	80	0
			B15	2	0	0	13	105	0
11	Meaningful learning	1	B21	74	37	0	0	9	0
12	Integrated teaching	1	B25	70	31	14	3	1	1

*Notes: The scores denote the total counts of students (N=120) with respect to Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. For positively written items, higher the counts mean strong agreement; For negatively worded items shown in shaded rows, higher counts means disagreement.

RESULTS

It can be seen from Table 1 that the number of counts on Agree or Disagree are consistently high and the counts of Disagree or Strongly Disagree counts are consistently Low on 18 items written in positive style. In contrast, the Agree/Strongly Agree counts are very low and Disagree/Strongly Disagree counts are very high in respect of items which are negatively worded viz., item numbers B8, B10, B14, B19, B21, B23, B25. This shows that the students are strongly in favor of PSE and integrated teaching as effective methods, against conventional didactic teaching.

In order to quantify the degree of agreement and disagreement on the 12 attributes listed in the Likert scale, we added the counts of Agree + Strongly Agree scores for the positively worded items and Disagree+Strongly Disagree counts for the negatively worded items, ignoring the Neutral responses (Undecided) given by the respondents. We converted these counts in to percentage with respect to highest possible counts. For example, for an attribute which is tested through one item only, the highest possible count is 120 including non-respondents. If there are two items, the highest possible score is 240. Table 2 shows the percentage of agreement or disagreement for each of the 12 attributes.

Table 2: Table showing total possible rating scores and agreement or disagreement scores against each attribute of the Problem Solving Exercise referred in Likert Scale (N=120)

Sr. No.	Attribute of Problem Solving Exercise	Total possible counts*	Agreement counts	%	Disagreement counts	%
1	Team work	120	117	97.50	0	0.00
2	Facilitating communication	240	229	95.42	2	0.83
3	Use of multiple strategies	120	114	95.00	4	3.33
4	Motivation for learning	240	225	93.75	2	0.83
5	Application for clinical setting	360	336	93.33	0	0.00
6	Meaningful learning	120	111	92.50	9	7.50
7	Teacher attitude	360	333	92.50	11	3.05
8	Linking information with previous experiences	120	110	91.67	0	0.00
9	High interactivity	360	325	90.28	12	3.33
10	Increase in reasoning skills	360	324	90.00	18	5.00
11	Overall Satisfaction	480	424	88.33	20	4.17
12	Integrated teaching	120	101	84.17	4	3.33

Note:

1. Agreement scores are arrived after adding the counts of 'Agree' and 'Strongly Agree' for positively worded items; In case of negatively worded items, the counts of 'Disagree' and 'Strongly Disagree' are added together. The counts in respect of 'Neutral' category are eliminated.
2. Percentage of 'agreement' is worked out on the basis of 'agreement counts' vis-à-vis, total possible counts. Total possible number counts for one item is 120; For two items, it is 240, etc.

The table shows that the percentage agreement scores for each attribute are very high and range between 84.17% (Attribute of Integrated Teaching) and 97.50% (team work). Similarly the percentage Disagreement Scores are very low ranging between 0 (team work) and 7.50 (Meaningful learning).

DISCUSSION

We assessed the perception of undergraduate students regarding on the use of problem solving exercises and integrated teaching in radiology. Our results show that students perceive PSE as an effective intervention for enhancing learning. Our findings are in conformity with many other previous studies. It is difficult to ascribe the positive perception of students to a single factor such as problem solving exercise, interactive style of teaching or integrated teaching in isolation. The contributory factors might be such as inherent benefits of problem solving aided by cognitive processing of data, the effect of visual media and the role played by PACS in image recognition by visual perception. The integrated teaching also might have contributed in giving a 'holistic approach' to the case as against looking at the anatomy, patho-physiology or clinical symptoms in isolation.

Our findings are consistent with the theories of learning and their implications on the practice.[10] The development of skills such as interpretation and problem solving, require higher cognitive processing, aided through 'contextual learning', which is the major plank of PBL or CBL[11] The problem solving exercises, coupled with the integrated teaching might have played major role in enhancing the student performance in this domain.

The General Professional Education of the Physicians Report (GPEP Report, 1984) recommended that the experience gained in approaching, analyzing and solving problems are highly desirable since they form the basis for subsequent clinical practice.[12] The popularity of Problem Based Learning coupled with the availability of

computer based simulations led to the increased application of problem solving exercises, and e-learning modalities to supplement traditional learning. Dichter et al 1990 have described that clinical problem solving exercises provide an orthogonal approach to organizing medical knowledge.[13] The organ system approach to bridge basic sciences and clinical sciences reported by Howland et al[14] and the 'new pathways in general medicine described by Tosteson[15] and are some of the early efforts to bring about integrated teaching.

Nyhsen et al studied students' perspective of quality of radiology teaching received, preferred teaching methods and resources through a questionnaire survey.[16] A majority of students belonging to both third year and fifth year rated interactive case based teaching as most effective form of teaching. The second most popular choice was interactive 'systems based teaching'. Self directed learning resources such as text books, journals and even online modules were perceived as less effective. Interestingly, e-learning modules were rated as less effective than self-directed study from text books. The authors have cited several instances of successful integration of radiology with anatomy and physiology, by assessing students' perception of the same. They concluded that "medical schools should be encouraged to introduce students to the basics of diagnostic imaging in the early undergraduate years, integrating this with system based and case based teaching during the preclinical and clinical phases of the curriculum."

Locksmith et al compared interactive, small group teaching with traditional teaching. The students' ratings on the interactive style was higher (4.6 on a five point scale) compared with traditional format (3.3).[17]

Zou et al studied medical students' preferences in radiology education and concluded that interactive teaching style was most preferred method of teaching.[18] Maleek et al, conducted a media comparison study for Case-based teaching in radiology and concluded that interactivity subjectively improves concentration and enjoyment, with significantly better learning outcome.[19] Arjun Singh, studied student performance and their perception of a patient-oriented problem solving approach using audio-visual aids in teaching pathology. Most of students were in favor of the new method of teaching against didactic teaching.[20] Nadeem N et al conducted a survey of radiologists and residents working in two private and two public teaching hospitals in Karachi, Pakistan. According to their findings the most preferred teaching methodology was one-on-one interaction. Tutorials, teaching rounds, PBL sessions were reported as less favored methods by the radiologists. Teaching via radiology films was in general the most frequent method of instruction.[21] They have also voiced concern over the need for addressing the award structure for radiology faculty, which holds good in the Indian context.

Mamede et al have described how students' diagnostic competence can benefit most from clinical case scenario approach.[22] Brigid and Linda have reported a deep understanding amongst students subjected to collaborative methods.[23]

Integrated teaching in the form of either horizontal integration (e.g., radiology along-with basic sciences) and vertical integration (e.g., anatomy, radiology and surgery) have been reported as successful teaching strategies in contrast with the disciplinary approach, which is followed in the Indian context.

Kourdioukova et al in their analysis of radiology education in the Europe claim that vertical integration starting with first year leads to more effective education from students' perspective and helps them to develop a positive attitude towards radiology.[24]

Ogur et al[25] have reported the experience of Harvard Medical school in redesigning first clinical year as integrated clerkship. The results showed comparable student performance in conventional and integrated streams. However, students who had integrated clerkship reported confidence to deal with ethical issues, see patients holistically and demonstrate better caring. Many of the European countries are moving towards different degree of integrated teaching at various levels. Radiology is fully integrated into 6 year medical curriculum in United Arab Emirates University.[26]

Bhogal P et al.[27] in their commentary have reported several examples of integrated teaching in radiology across the world. According to their view, "Whilst the exact time and extent of integration will vary between institutions and be dependent upon the local obstacles……, we would prefer early integration of radiology in to the undergraduate curriculum….. The integration of radiology in preclinical years will give students a deeper understanding of basic sciences, whilst in the clinical years will allow the students to understand how radiology is intrinsic to the diagnostic and management decisions of virtually all patients. It will also give an insight into multidisciplinary approach to patient care."

Considering the global trend to promote integration, there is much scope for the Indian medical colleges to work in this direction. Sood and Sharan have reported integrated teaching of mental health in which faculty from Community Medicine and Psychiatry participate.[28]

Innovative teaching cannot be grafted in a vacuum. It requires a fertile soil in the form of a good infrastructure and resources for managing learning, and an assessment system aligned with the learning outcomes.[29] Achieving integration in the context of 'silos' created by departments appears committed leadership, motivated faculty and persuasion by individual efforts. A well crafted Faculty Development Program (FDP) is

indispensible for preparing the faculty to implement innovative methods in letter and spirit.[30]

Our study has several limitations. The validity and reliability of the tool which we used to measure the perception of students need to be assessed through further studies. The positive results may be due to the novelty of the intervention. Other limitations are the study sample limited to a single institute, and a single batch of students recruited for the study. What we plan to do as a next step is to repeat the intervention, 'cross over' the methods for the new batch so that we have some additional data to support our claim.

CONCLUSION

We conclude that innovative approach to the teaching of radiology in the form of problem solving exercises and integrated teaching is feasible. Such efforts should be extended to other medical colleges. Though there are constraints in terms of shortage of time and committed faculty, the developments in the field of IT and introduction of learning management systems, should act as game changers. In the ultimate analysis, it is the competency of the graduate which matters more than passive learning and acquisition of information.

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