

# Peer Teaching to Foster Learning in Physiology

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## ABSTRACT

**Introduction:** Peer teaching is an effective tool to promote learning and retention of knowledge. By preparing to teach, students are encouraged to construct their own learning program, so that they can explain effectively to fellow learners. Peer teaching is introduced in present study to foster learning and pedagogical skills amongst first year medical under-graduates in physiology with a Hypothesis that teaching is linked to learning on part of the teacher.

**Materials and Methods:** Non-randomized, Interventional study, with mixed methods design. Cases experienced peer teaching whereas controls underwent tutorials for four consecutive classes. Quantitative Evaluation was done through pre/post test score analysis for Class average normalized gain and tests of significance, difference in average score in surprise class test after one month and percentage of responses in closed ended items of feedback questionnaire. Qualitative Evaluation was done through categorization of open ended items and coding of reflective statements.

**Results:** The average pre and post test score was statistically significant within cases ( $p = 0.01$ ) and controls ( $p = 0.023$ ). The average post test scores was more for cases though not statistically significant. The class average normalized gain ( $g$ ) for Tutorials was 49% and for peer teaching 53%. Surprise test had average scoring of 36 marks (out of 50) for controls and 41 marks for cases. Analysed section wise, the average score was better for Long answer question (LAQ) in cases. Section wise analysis suggested that through peer teaching, retention was better for descriptive answers as LAQ has better average score in cases. Feedback responses were predominantly positive for efficacy of peer teaching as a learning method. The reflective statements were sorted into reflection in action, reflection on action, claiming evidence, describing experience, and recognizing discrepancies.

**Conclusion:** Teaching can stimulate further learning as it involves interplay of three processes: metacognitive awareness; deliberate practice, and self-explanation. Coupled with immediate feedback and reflective exercises, learning can be measurably enhanced along with improved teaching skills.

**Keywords:** Pedagogical skills, Peer assisted learning, Undergraduate Medical Education

## INTRODUCTION

It is rightly stated that "The fundamental pedagogy of Medical Education aims to have learners develop motivation and skill required to teach themselves, stimulated by clinical experiences..." [1]. The science behind comprehensive learning has always emphasized the involvement and contributions of learners in learning process. Effective learning in medicine, on the pedagogic side, requires involvement of learners in the actual activity rather than simple observation, listening and memorization [2]. Hence, while designing and implementing learning activities, focus should be diverted towards Peer assisted learning (PAL) activities. It encourages student engagement behaviorally, emotionally, and cognitively which, in the long run, affect academic achievement positively. Lately, teaching assignments to foster learner's engagement in the learning process has been gaining attention in undergraduate medical education. By preparing to teach, students are encouraged to construct their own learning program and encourages comprehensive learning [3,4]. Of the several proposed reasons of peer teaching in medical education, one significant is that it equips medical students with a better understanding of teaching and learning principles and in turn they may become better learners [5,6]. Peer teaching supports this principle where the learner actually teaches what he needs to learn. Resultantly, it fosters a sense of Efficacy, Coach the learners to Reflect on learning activities, Promote Mastery Orientations, Provide Autonomy Support and encourages better participation by other students [7-11]. It promotes an internal locus of control rather than compliance with directives and commands, and as a result, learner's engagement levels increase [9]. Evidently they may have a greater retention and grasp of the subject matter when they teach and can be an effective model to refine the knowledge of the student tutor in the subject area being taught [12,13]. The

teaching task itself can serve as a powerful motivation for deeper learning [12]. Literature suggests different PAL techniques which can be adopted to engage learners in teaching activities e.g.: Horizontal and Vertical, Discussion groups, Reciprocal peer tutoring, undergraduate teaching assistants, class wide peer tutoring etc [12,13]. However, these techniques require periodical guidance by mentors, and their application to medical education has not been well explored yet. Implementing this method of learning presents a challenge to curriculum organizers in terms of content, timing and student interest to facilitate the development of undergraduate medical student's teaching skills [14].

The present study attempts to generate evidence for 'teacher-learner duality' i.e. teaching is linked to learning on the part of the teacher. The most relevant factors being social interaction, self-explanation, deliberate practice with feedback, and Metacognitive higher order thinking which involves active control over the cognitive processes engaged in learning.

**Rationale:** Based on the concept of "to teach is to learn twice", Peer teaching is introduced to foster learning and pedagogical skills amongst first year medical under-graduates. The hypothesis driving the study is that Medical students with a better understanding of teaching and learning principles become better learners, as while teaching students, they not only improve their teaching skills, but also their theoretical knowledge and clinical competence. Here, peer teaching is compared with tutorials which is mainly a teacher controlled activity. During tutorials, students are encouraged to participate and express their opinions [15]. However, common observation is that very few motivated students are well prepared and participate actively, whereas others are merely passive listeners.

## OBJECTIVES

1. To sensitize 1<sup>st</sup> year medical undergraduates regarding teaching skills.
2. To incorporate peer teaching in physiology for better learning.
3. To analyse the impact of peer teaching with regards to gain in knowledge, attitude and acceptance by undergraduate students.
4. To compare learning outcomes by peer teaching, a student led activity and tutorials, a teacher led activity.
5. To suggest how peer teaching can be effectively utilized for better learning in physiology.

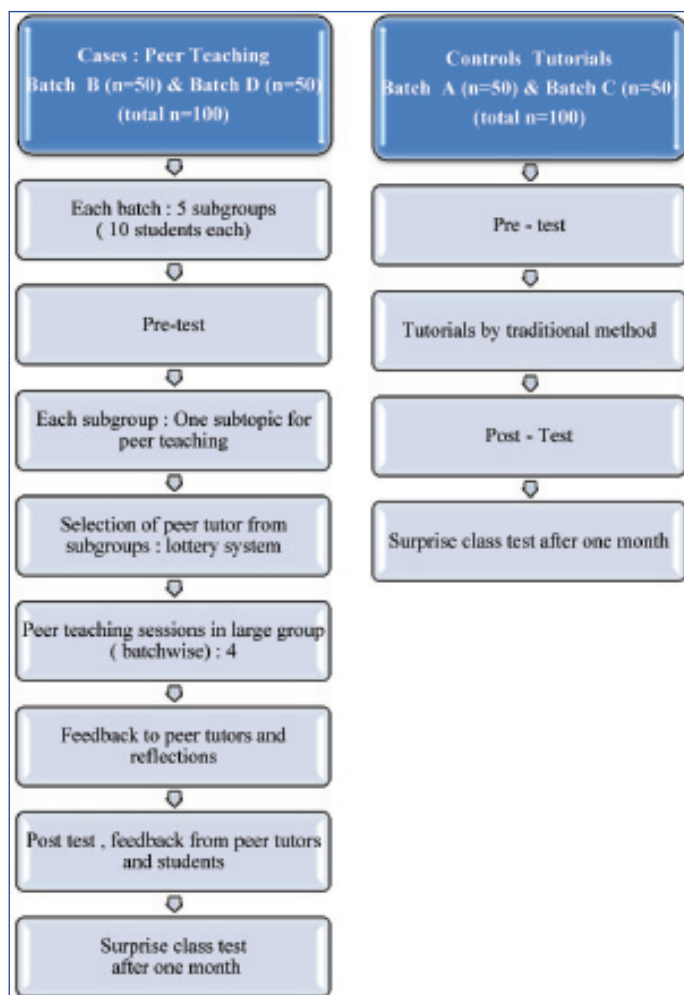
## MATERIALS AND METHODS

It was a non- randomized, Interventional study, with mixed methods design. Locus of study was Department of Physiology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences (Deemed University), Sawangi (M), Wardha, India. Ethical clearance was obtained and Informed consent was taken for participation in the study. Two hundred students of first MBBS were divided into four groups of 50 students each (Batch A,B,C&D). This is a routine method of splitting 200 students into 4 groups during conduction of tutorials in physiology. For the current study, two of the four batches (Batch B & D) were taken as cases (n=100) and two groups (Batch A&C) were taken as controls (n=100), as per convenience sampling. All the four batches were seated at four different demonstration rooms. The cases recruited had 42 male and 58 female students between age group of 17-18 years. Control group had 47 male and 53 female students between age group of 17-18 years. No student had any previous experience with Peer teaching.

**Controls:** The controls underwent tutorials conducted by faculty members on specified topics which were already taught by didactic method. As a routine practice, the tutorial topic is displayed at the beginning of the month and students are asked to be prepared with the topic. All the topics are taught by didactic method before hand. During tutorials, the given topic was discussed by the faculty and doubts were clarified.

**Cases:** Cases (n=100, batch B & batch D) were asked to be well prepared with the topic displayed at the beginning of the month. During actual class; each batch of 50 students were divided into 5 subgroups (10 students in each group). The topic to be discussed was split into five subtopics and each group was given one subtopic. After distributing the topics, each group was asked to prepare the topic for teaching in a large group. The students were made aware that the selection of tutors will be based on the lottery system, which prepared them mentally for the role. Lottery system of selection was intended to avoid bias. They were briefly sensitized about teaching skills and how they should conduct the teaching session. An orientation as to what is not PAL viz. it should not be targeted at weak students i.e. all participants should be benefitted and it is not a means of reducing existing faculty-student contact, was provided. Fifteen minutes were assigned to prepare the topic for teaching, after which one student was selected from each subgroup based on lottery system. All selected students enthusiastically agreed to be peer tutors. All 50 students were re-assembled and the selected students came forward sequentially to teach respective sub-topics. The media allowed for teaching was chalk and board. After teaching sessions were over, peer teachers were provided with group feedback where the faculty along with five peer teachers were seated together and discussed about: 1) What went well; 2) What needs to be improved and; 3) How it should be improved. The opinion and reflections of peer teachers were encouraged during feedback session and it was taken on record [Table/Fig-1].

A total of 4 topics were discussed by both the methods over a span of two weeks; each week comprising of two Tutorial/Peer



[Table/Fig-1]: Plan of work

teaching classes, of one hour duration. The four topics taken were: 1) Regulation of Respiration; 2) Mechanism of Urine formation; 3) Regulation of Blood pressure and; 4) Thyroid hormone.

## Data Collection

Multiple Choice Questions (MCQ) based Pre-test and Post-test were taken for both cases and controls. Ten MCQs were framed for each topic which included MCQs of simple recall-4, understanding -3 and application (problem based)- 4. Pre-validated questionnaire based feedback was obtained from peer teachers and students who witnessed peer teaching sessions, regarding their perception about peer teaching. Verbal Opinions and reflective statement of peer teachers were recorded. A surprise class test was conducted for both cases and controls after a month, which consisted of questions from the four topics which were discussed as a part of study. The test comprised of 20 MCQ - 1 mark each, 7 Short answer questions (SAQ) - 2 marks each, and two long answer questions LAQ- 8 marks each, making a total of 40 marks.

## STATISTICAL ANALYSIS

### Quantitative Data

Parametric test of significance, Paired t-test was applied for comparing the pre and post test scores of cases as well as controls. Unpaired t-test was applied for comparing post test scores between cases and controls ( $p < 0.5$  was considered significant). Class average normalized gain was calculated for pre and post test of cases and controls, as follows:

$$\langle g \rangle = \{ (\% \text{ Post test}) - (\% \text{ Pre test}) \} / \{ 100\% - (\% \text{ Pre -test}) \} [11]$$

A predefined target  $\langle g \rangle$  of 30% was taken as defining the minimum value at which the educational intervention could be regarded as effective [16-18]. The results of surprise test of cases were

compared with controls. The marks were analysed for total score and for scores in different sections of question paper; viz MCQ, SAQ and LAQ. The percentage of responses was analysed for closed ended items of feedback questionnaire.

### Qualitative Data

Open ended responses were analysed by categorization and charting percentage of responses. The reflective statements were recorded verbatim and categorized into five type of reflective statements.

## RESULTS

During course of the study, 3 cases and 4 controls were excluded from the study because they were absent in one /two sessions.

The average pre and post test scores were calculated for the entire 4 sessions taken together. The average pre and post test score was 2.9 and 7.012 respectively in controls ( $p = 0.023$ ) and 2.8 and 7.4 respectively in cases ( $p = 0.011$ ); both statistically significant ( $p < 0.05$  was considered statistically significant). The average post test scores between cases and controls were more for cases (7.4), though not statistically significant. The class average normalized gain was (g) for Tutorials were 49% and for peer teaching was 53%.

The surprise class test had average scoring of 36 marks (out of 50) for control group and 41 marks for cases. Analysed section wise, the average scoring in MCQ (MM – 20), SAQ (MM – 14) and LAQ (MM – 16) was 14, 10 and 9 for controls and 15, 10 and 12 for cases. The section wise analysis suggested that through peer teaching, retention was better for descriptive answers as LAQ has better average score in cases. Rest of the sections (MCQ& SAQ) had almost similar average scores.

According to student perception, 66.16 % of them felt that Peer Teaching was stressful and taxing; however, they agreed to strongly agree that it made them more confident about the topic and helped in learning. The peer teachers endorsed feedback as helpful (100%) and prompted them to reflect upon their own teaching and knowledge gaps (98.22%) [Table/Fig-2]. The students attending peer teaching (n=87) found it motivating and helpful and depicted positive inclination towards such practices in future. Majority of the students agreed that it prompted them to pay attention in the class (96.19%), though a small percentage of students disagreed (3.81%) [Table/Fig-3].

S. No	Item	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1	I was briefed about teaching skills by the faculty				85.36	14.64
2	Teaching was stressful and taxing		33.84		53.81	12.35
3	By teaching, I became more confident about the topic				6.46	93.54
4	Teaching enhanced my learning				89.7	10.3
5	I would like to teach again to my fellow students			10.54	80.0	9.46
6	Feedback was given to me after teaching will be helpful to improve my knowledge and teaching skills				1.68	98.32
7	The feedback encouraged me to self assess my teaching			1.78	88.75	9.47

[Table/Fig-2]: Percentage of responses in Feedback questionnaire to closed ended items of students who performed as peer teachers (n= 20)

S. No	Item	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1	Class taken by fellow student was enjoyable			8.93	4.61	86.46
2	Peer teaching tempted me to pay attention		3.81		39.8	56.39
3	By listening to peer, I was motivated to teach				54.78	45.22
4	Teaching by peers should be encouraged				11.38	88.62
5	Peer teaching is a waste of time	64.97	35.03			
6	This method will help me to remember the topic in a better way			14.86	48.59	36.55
7	Given a chance, I would like to teach		2.67		24.09	73.24

[Table/Fig-3]: Percentage of responses in Feedback questionnaire to closed ended items of students who attended peer teaching sessions (n= 87)

Thematic segregation of responses	What was the best part about my experience as a teacher? (few excerpts)
Self directed learning	"I now know the topic better" (40%)
	"I think that way you improve your knowledge about the topic"
	"it helps in better learning" (35%)
	"doubts were clarified"
Self Assessment	"you have to be better prepared for teaching"
	"I could make out how much I know about the topic "
Enjoyable	"I came to know how much I fair as teacher"
	"it was an interesting exercise" (65%)
	"I found it really challenging"
Motivating	"everything was good... enjoyed thoroughly"
	"it motivated me to read more about the topic so that I can explain well"
Enhanced learning	"because I had to teach, I read the topic properly" – (60%)
	"I will now remember it well" – (86%)
	"I can write and explain the topic well" – (55%)
	"will be helpful for appearing in exams"

[Table/Fig-4]: Categorization of responses with percentage distribution of frequently occurring responses to "What was the best part about my experience as a teacher?"

Open ended responses to "What was the best part about my experience as a teacher?" were categorized into: 1) Self directed learning; 2) Self Assessment; 3) Enjoyable; 4) Motivating, & 5) Enhanced learning [Table/Fig-4]. Most of the peer teachers found the whole exercise enjoyable, encouraging and helpful in learning. Responses of peer teachers to "How I could have done better?" could be sorted into three categories i.e. Better preparation, More guidance and Alternate teaching media [Table/Fig-5]. They felt that more preparation time, added guidance and permission to use power point presentations might have helped them to perform in a better way. With regards to best part about peer teaching method, students who attended the sessions felt that it made the class interesting and prompted them to learn together [Table/Fig-6]. Ninety six percent of students felt that this should be practiced often as it will help them in comprehensive learning in and interesting way [Table/Fig-7]. The verbal opinion and reflective statements were categorized into reflection in action, reflection on action, claiming evidence, describing experience, and recognizing discrepancies [Table/Fig-8].

Thematic segregation of responses	How I could have done better?
Better Preparation	"by getting more time for preparation" – 70%
	"by previous experience"
	"by watching other fellow students teach"
	"by practice" - 43%
	"next time I will do better"
More Guidance	"by more guidance about how to teach" – 37%
	"by discussing what and how I will teach, with the faculty"
Alternate Teaching media	"with power point presentation" – 29%
	"probably if presentation was allowed... I would not have missed certain points"

**[Table/Fig-5]:** Categorization of responses with percentage distribution of frequently occurring responses to "How I could have done better?"

Thematic segregation of responses	What was the best part about being taught by peer?
Interesting	"it made the class interesting"
	"it was a different experience "
	"I remembered my school days when we used to teach during teachers day"
Collaborative learning	"we read the topic properly as anyone would have been chosen for teaching"
	"this way we could learn better"
	"I think it will also improve teaching skills"
	"motivates to learn more"
	"remember it in a better way"

**[Table/Fig-6]:** Categorization of responses with percentage distribution of frequently occurring responses to "How I could have done better?"

Tutorial being mainly a teacher-controlled activity, though students were encouraged to participate, there was a limited opportunity to express their opinions [15]. Faculty tutors reported active participation by only few motivated students, whereas others were mere passive listeners.

## DISCUSSION

PAL has been effective in learning process, self directed and collaborative learning [19]. Medical students, as a part of their professional career, are always involved in teaching, as they become sources of health information for patients, family, friends and during

their clerkship. While undergoing the process of preparing to teach, they show better understanding of complex concepts [20]. This is believed to occur through learners' detection and repair of defective mental models [21,22]. Since its conception, there have been many attempts by medical educationists to formalize peer-teaching, a method of PAL, in both undergraduate [23-26] and postgraduate settings [27-29]. In United Kingdom, acknowledgment of peer-teaching and its associated benefits has been formally expressed by the General Medical Council (GMC) whose statement maintains that medical graduates "must be able to demonstrate appropriate teaching skills" [30].

The current study was an attempt to generate evidence about the potential of teaching practice as an effective method of self-directed learning in Physiology. There are significant hours dedicated to tutorials as a method of teaching Physiology at our Institute. However, challenges of decreased faculty strength (as per regulatory requirements) and increased number of students are major limiting factors. We directed our efforts to suggest and evaluate the efficacy of an alternative method without disturbing the curricular framework and yet ensuring maximum participation with better learning. Similar rationale was shared by a study conducted by Durán CE et al., for teaching anatomy course by final year medical students due to low faculty strength [31]. Other aspects of learning like working in a team, presentation skills, and critical-thinking were also fostered by peer teaching, which is often neglected in tutorials.

Thematic segregation of responses	"Should this exercise be conducted more often? – State reasons."
	Yes : 96%
	No response : 3%
	No: 1%
Reasons	"it motivates us to read the topic properly" – 74%
	"that way we were forced to read so that we can explain well"
	"it is enjoyable experience" "enjoyable" "interesting class" etc. – 59%
	"better than routine revision classes"
	"its fun!"
	"I can learn properly"
	"by observing fellow-mates teach, we get inspired"

**[Table/Fig-7]:** Categorization of responses with percentage distribution of frequently occurring responses to "Should this exercise be conducted more often? – State reasons"

### Analysis of Reflective statements:

	Coding of type of reflective statements	1 <sup>st</sup> peer teaching session	2 <sup>nd</sup> peer teaching session	3 <sup>rd</sup> peer teaching session	4 <sup>th</sup> peer teaching session
1	Reflection in action	"I initially felt reluctant but later on I became cool. In fact I found myself enjoying the whole act of teaching!"		"As I started I looked at my friends and became a bit conscious...I immediately focused my gaze on the tutor"	"one student indicated me to hold the mike more close... probably I was not audible for initial few minutes."
2	Reflection on action		"Probably next time I will be more confident. I know how much preparation is required to teach... and that too with chalk board"	"When I think about the whole experience, I feel I should have first noted down the points I wish to teach... that way I will not miss anything"	
3	Claiming evidence				"I thought I was going too fast, but when one student could answer my question, I was relaxed"
4	Describing experience	"I was tensed as I had to teach without power point . I just revised the whole thing in mind. I could now remember few things which were left out, because of stress. Next time, I will be in better position to teach"		"I just couldn't recall the name of "apneustic centre" lit was a complete mental shut down. Someone prompted from the audience and then I could go ahead. But it was wonderful experience acting as a teacher"	"It was good to read the topic beforehand... I could be confident because I had read it well"
5	Recognizing discrepancies				"I later realised that I have not covered the intermediate regulation of blood pressure."

**[Table/Fig-8]:** Thematic segregation of reflective statements and its verbatim record under respective themes

Most of the learners found teaching exercise enjoyable and helpful in learning. Similar observations were recorded by Bardach et al., in "Teach how to Teach" sessions of Final MBBS students where the students strongly endorsed the program and agreed that formal instruction in teaching should be a required part of medical education [32]. A plausible explanation is that in response to learners' questions, teachers must generate sensible self-explanations before offering explanations to their students, and this self-explanation stimulates further learning on the part of the teacher. The process of preparing to teach helps the students to organize and authenticate their knowledge [33]. Comparable annotations were recorded by Darrell J et al., regarding advantage of using near-peer teachers to reinforce and expand their own learning and develop essential teaching skills [34]. Feedback from participants, in the same study, suggested that the program fulfill its aim of providing an effective environment for developing deeper learning through teaching, which is also analogous to the findings in current study.

Though, only four teaching sessions were conducted in the present study and that two with different peer tutors, their readiness for further such sessions (in feedback) evidences their enhanced confidence levels. They found themselves better prepared for subsequent teaching sessions. Almost all peer tutors agreed that this exercise should be a part of their regular teaching learning activities. Consequentially, better average score in LAQ amongst cases can be contemplated as an indicator for better understanding, comprehension and retention of physiological principles and elucidations. Peer tutors strongly agreed that feedback (after teaching) helped them to diagnose their learning needs and how they can improve their teaching skills. The importance of self-reflection was well recognized in perceptions recorded as it consolidated the learning process [35,36]. Prompting reflections encouraged them to learn from personal experience and inculcate the habit of taking responsibility for one's actions and decisions. Though very few studies have been undertaken in undergraduate medical education in this context, almost all of them report positive reaction from the learners and a general perception to be included as a part of routine teaching learning activity [14,23,37-39]. The reported benefits are seen through a greater openness in classes, with increased access, involvement, interest in learning, and confidence in participating [40,41].

The study also recorded feedback of students who actually attended the peer teaching classes. They found the whole activity motivating and encouraging. Being taught by fellow student was a reason which prompted them to be attentive and it also provoked them to be well prepared with the topic. According to education theory, medical students learning and applying teaching principles may become active participants in their own learning process. A systematic review of Medical students-as-teachers, in this regard states that Peer-teaching in undergraduate medical programs is comparable to conventional teaching when utilized in selected contexts with a strong evidence to suggest that participating student-teachers benefit academically and professionally, though most of the outcomes are short term without any evidence of long term impact [42].

#### Advantages which emerged, can be listed as follows:

1. Direct interaction between students promotes active learning.
2. There is reinforcement of peer teacher's own learning while teaching others.
3. There is a comfort zone created between peer teacher and student, which aids interaction and learning.
4. The retention of knowledge is better as it fosters focused, self-directed learning.
5. Medical students may become more effective communicators, as teaching is an essential aspect of physician-patient interaction.

## LIMITATIONS OF THE STUDY

1. Inadequate preparation and insufficient information on curriculum resulted in student apprehension.
2. Lack of evidence demonstrating the possible long-term impacts of peer-teaching on life-long learning skills, leadership skills, and professionalism
3. Increase in self-confidence ratings cannot be considered reliable data for measuring the efficacy of this method in terms of learning outcomes.

## CONCLUSION

Teaching can stimulate further learning by the teacher as it involves interplay of three processes: metacognitive awareness; deliberate practice, and self-explanation. Coupled with immediate feedback and reflective exercises, learning can be measurably enhanced along with improved teaching skills in subsequent sessions. Not only is it useful for peer teachers, but also for students attending those classes, as they get intrinsically motivated to learn and to teach. It is effective in inculcating teaching skills right from undergraduate years and goes a long way in building professional competencies required at every phase of a medical professional. Efforts should be directed to incorporate peer teaching as a part of curricular strategies on a larger scale for re-enforcement of knowledge and learning in a collaborative manner.

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Date of Submission: **May 27, 2015**  
Date of Peer Review: **Jul 02, 2015**  
Date of Acceptance: **Jul 15, 2015**  
Date of Publishing: **Aug 01, 2015**

FINANCIAL OR OTHER COMPETING INTERESTS: None.