

Medical Education / Original Article

## Jigsaw Method : An Innovative Way of Cooperative Learning in Physiology

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### Abstract

Jigsaw activity was introduced to promote peer interaction and cooperation for learning in Physiology. The activity was performed on 1<sup>st</sup> semester MBBS students after delivering didactic lectures on the selected topics. The topic selected was “Mechanics of Respiration”, which was further divided into 10 sub-topics. The students were randomly divided into 10 parent groups, with 10 students in each. Each member of the parent group was assigned a specific sub-topic to prepare. Thereafter, all the students from the parent groups with similar topics formed expert groups to discuss and excel the given sub-topic. Subsequently, all the students returned to their respective parent groups to explain the assigned topics to their group members. A member of each parent group was then asked to present a randomly selected sub-topic.

A feedback questionnaire was administered to the students; they found the Jigsaw method to be a healthy way to interact with peers, making learning interesting & effective. It also enabled them to comprehend better and enhance their communication skills. They were fairly satisfied by this teaching learning innovation.

### Introduction

The Jigsaw method is a form of cooperative learning, in which students are actively involved in the teaching-learning process (1, 2). The ‘SPICES’ model of medical curriculum recommends a paradigm shift from teacher-centered to student-centered learning. Active engagement of learners has shown to improve

long-term retention of acquired knowledge (6, 14). Incorporation of active learning strategies into conventional passive learning approaches has resulted in improved students’ performance (9, 12). The Medical Council of India (Vision 2015) categorically emphasises self directed learning and encourages learner centric approaches (13).

The jigsaw method has not only shown to build comprehension, it also encourages cooperativity among students. It is further known to improve listening and communication skills (4, 7, 15, 16). This method has been successfully tried in various areas of education like elementary or primary education (8, 20, 21) nursing education (4, 22),

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pharmacy (7, 16, 18) and in other fields (15, 17) but less so in medical subjects (3, 5, 19). Literature search could not yield any published articles on the use of Jigsaw method for Physiology teaching.

In this study, modified Jigsaw learning activity was implemented with the aim of promoting peer interaction and cooperation for studying Physiology; and its effectiveness and students' perception were measured using a validated feedback questionnaire.

## Methodology

The present study was conducted with MBBS First Professional students (preclinical year, first semester) in the Department of Physiology at our institute. The task was a part of routine unconventional activity during tutorial hours. The activity was commenced after approval from the Institutional Ethics Committee. The feedback questionnaire was completed after obtaining consent from the participants in the study. They were asked not to record their names, and no personally identifiable information was obtained in the questionnaire to preserve anonymity.

Faculty members and residents were sensitized by discussing with them the proposed plan of study.

The activity was carried out after delivering conventional didactic lectures to the students on the selected topics from "Respiratory Physiology". The activity was completed during tutorial hours in 4 sessions spanning 3 weeks. The whole task was executed in the presence of the facilitators.

The unit selected for Jigsaw activity was Respiratory Physiology; the topic was "Mechanics of Respiration". The sub-topics assigned to the members of the "parent group" were :

1. Functional anatomy of respiratory system
2. Mechanism of inspiration and expiration
3. Respiratory membrane and diffusion across it

4. Spirometry and the role of FVC and FEV<sub>1</sub> in the diagnosis of ventilatory disorders
5. Functional Residual capacity; its significance and measurement
6. Ventilation-perfusion ratio
7. Compliance of the lungs and chest wall
8. Pulmonary resistance
9. Alveolar surface tension and the role of surfactant
10. Work of breathing

The steps involved in the jigsaw strategy were adapted from Aronson with slight modifications and are shown in Fig. 1 (2, 10). In the modified strategy, the students were asked to present a given sub-topic in front of the whole class.

The sessions were divided as follows :

1. Session 1: Students were explained in detail about the strategy. Ten groups, each consisting of 10 randomly selected members, were created. These were the "parent groups" which were named "A through J". Each member of the "parent group" e.g. parent group A with members A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub>,..., A<sub>10</sub>, was assigned one of the above mentioned sub-topics, such that each of the parent groups has members with 10 different sub-topics. Next, the students who were assigned same sub-topics in all the 10 parent groups collected to form "expert groups". Thus we had 10 "expert groups", named "1 through 10" (e.g. Expert group 2 constituted members- A<sub>2</sub>, B<sub>2</sub>, C<sub>2</sub>... J<sub>2</sub>). The students were asked to prepare the sub-topics for discussion in their respective "expert group" in the next session. Since 2 students were absent during the activity, one of the member was assigned two topics for discussion, so that none of the topic is missed by any "parent group".
2. Session 2: The expert group worked together for an hour, discussing all the aspects of the given

sub-topic, using all the available resources and clearing their doubts, if any, from the facilitators.

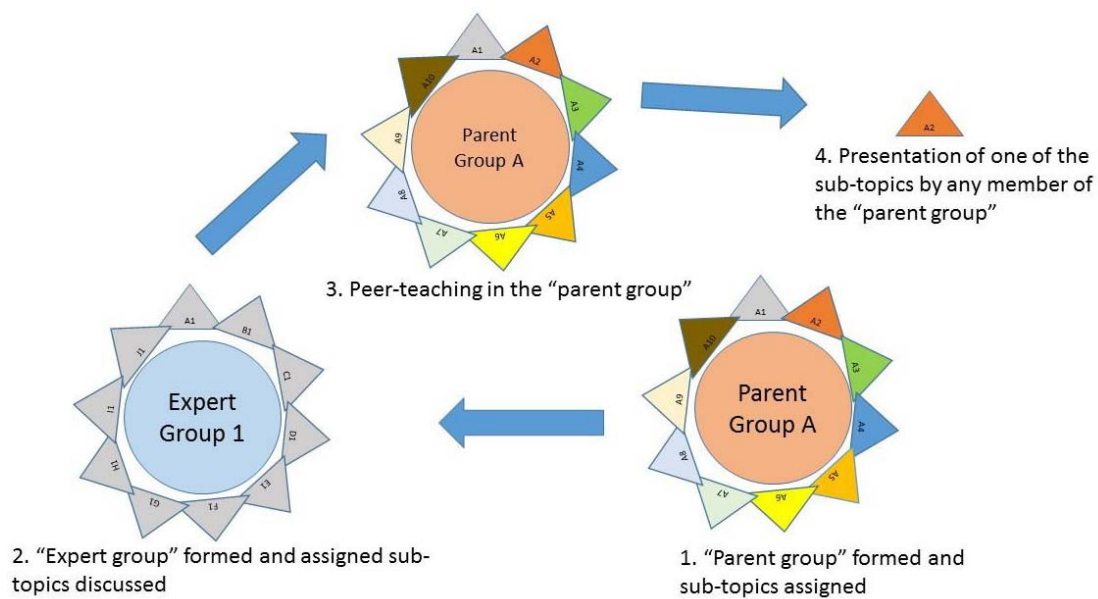
3. Session 3: The members returned back to their respective “parent group”. Subsequently, each expert provided the fellow members with all the information gathered through the discussion in the “expert group”. Students were informed in advance that “parent group” members need to learn all the sub-topics from one another and any of the members could be asked to speak on any of the sub-topic.
4. Session 4: The last session was of 4 hours duration, in which one member from each “parent group” was randomly selected and asked to teach a particular topic to the whole class. The student was permitted to use chalk and board for the same. Since all topics could not be discussed the same day, this session was continued in the subsequent tutorial class. The students were also encouraged to ask questions from the presenter if they had any, at the end of the presentation. The presentation session was not recommended in the original jigsaw method; it has been added in the modified version, to overcome hesitation/shyness and improve communication skills among students. Thereafter, effectiveness of this learning experience was evaluated by the students through

a pre-validated feedback questionnaire (14). Ninety-five students completed the survey. The questionnaire had two types of questions: 1) questions with a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree) to assess their learning experience, perception towards the activity, and the level of satisfaction with the activity and 2) open-ended question directed at suggestions/ comments with regards to the use of the Jigsaw technique to learn new concepts in Physiology.

## Results

The study was intended to implement Jigsaw method of cooperative learning and peer-teaching for mastering some concepts in Respiratory Physiology. One hundred students were enrolled for the study, 98 were present till 3<sup>rd</sup> session of the activity. Ninety-five students participated in the last session, which included students’ presentation and feedback. All the students fell into the age range of 17-19 years. None of the students had previous experience with the jigsaw technique.

After completion of the study protocol (Fig. 1), the students were asked to provide their feedback through administration of a pre-validated questionnaire; they



Steps for Jigsaw method of learning.

were also asked an open-ended question about the apparent advantages and disadvantages of using the jigsaw technique to learn physiology concepts.

Feedback from students about the various aspects of the learning activity using a Likert scale is shown in Table I. The average rating of each item in the questionnaire ranged from 3.64 to 4.19. The minimum average score was 3.64 for item 4, which stated that thorough discussion on the topics increased analytical ability; a maximum mean score of 4.19 was obtained for item 2, which stated that the activity enabled in-depth coverage of the topic.

The satisfaction index for each item was calculated using the following formula :

$$\frac{[(n_1 * 1) + (n_2 * 2) + (n_4 * 4) + (n_5 * 5)] * 20}{(n_1 + n_2 + n_4 + n_5)}$$

Where, n is the total number of students gaining the score mentioned in the subscript for that particular item. The scores were rated on a 1–100 satisfaction index scale. It was highest (90.8) for item 2, emphasizing the fact that activity enabled in-depth coverage of the topic and lowest (76.9) for item 7, indicating that the activity did not help much in developing their teaching skills.

Table II shows some of the responses to the open-

ended question in the student feedback questionnaire, in which they were asked to express their views on the benefits or harms of the Jigsaw method and how this activity can further be improved and be made interesting.

Thus, the study observed high satisfaction scores of students towards different aspects of learning the topic, on a five point Likert scale. A positive response was also obtained on open ended feedback regarding this teaching learning methodology.

## Discussion

The study aimed at promoting co-operative learning among medical students through a modified jigsaw method of teaching and learning. It included Group discussion, Peer teaching and Presentations of the learned topic, in front of the whole class.

Group discussion among the members of the “expert group “was carried out after thorough research in the topic. This helped in wide coverage of the topic from various sources and enhancement of in-depth knowledge as suggested by their open-ended responses and high satisfaction index for item 2 in the questionnaire. Newer ideas were put forward by all the members and imbibed by the fellow members, such that by the end of the session, each member was an expert in the concerned topic. Group

TABLE I: Responses to feedback questionnaire.

SN. Question	Strongly Disagree (1)	Disagree (2)	Uncertain (3)	Agree (4)	Strongly agree (5)	Satisfaction Index
1 The activity was useful in comprehending the given topic.	1	1	6	48	40	87.8
2 The activity enabled in-depth coverage of the topic.	0	2	8	34	51	90.8
3 The activity helped in enhancing communication skills.	0	6	18	55	16	81
4 A thorough discussion on the topics increased analytical ability.	0	8	19	49	19	80.8
5 The activity helped in overcoming shyness and hesitation in the class.	2	2	7	37	49	88.7
6 This form of exercise should be incorporated for all the topics in physiology.	3	3	21	46	25	82.6
7 The exercise ingrained teaching skills in the participants.	9	14	12	30	39	76.5
8 You are confident that this knowledge could be applied in clinical practice.	1	4	24	35	32	85.8
9 The exercise was enjoyable.	2	11	13	41	30	80.5
10 This is an effective way of learning.	0	1	11	45	38	88.6

Feedback responses of the 95 students and satisfaction index of each item.

TABLE II: Responses to open ended question.

<i>Core Idea</i>	<i>Representative comments</i>
<u>About the activity:</u>	
It promotes co-operative learning.	"It's a healthy way to interact with classmates." "I could relate to my class mates better now."
Effective way of learning and comprehending.	"Epic way of teaching- and learning" "It stimulated me to read the topics in detail." "I was able to understand the difficult aspect of the given topics" "I referred to internet for recent advances in the concerned field while preparing the topic." "The activity is good and should be given for other topics also." "Please keep us doing such activity."
Innovative teaching-learning method.	"I have a reason for not bunking the tutorials." "It's a novel way of teaching-learning." "Something to look forward in tutorials." "A good break from conventional tutorials."
Activity helped in improving communication skills and confidence.	"I am happy that I was able to put my words together during presentation." "I am more confident in making such presentations now."
<u>Suggestions:</u>	
Activity should be research oriented also.	"Newer advances should be discussed" "Research oriented topics should be included."
All the students should be encouraged to present the topic	"Shorter topics should be included so that no student is missed" "Books should be allowed to encourage more participation" "Hindi-medium students should be persuaded for the presentation"
Activity should be incentivised.	"Extra attendance or extra marks should be given" "Incentives should be given for presentation."
Hindrance to proxies!	"We fail to mark our friends' attendance due to one to one interaction." "Proxies should be allowed." "Teachers should be less strict in marking the attendance."

Core ideas that emerged in response to the open-ended question on the feedback questionnaire and their representative comments from the students.

discussion has been shown to improve comprehension and learning by Freeman et al, 2014; Lom B, 2012 and others (9, 11, 12).

In the next step, all the expert members returned to their "parent group". Peer teaching took place in the parent group, wherein all the expert members taught their respective sub-topics to the fellow members in the best way possible. This enhanced students' communication skill as evidenced from the response score of 81% to the item 3 and 88% to item 4. Similar results have been reported by other researchers also (14, 15, 16). This not just also helped them in improving their expression, it also instilled the quality of patient listening in them.

Subsequent presentations helped them in overcoming hesitation and shyness in the class. In this perspective (item 5), the students were satisfied (88.75%) by this method of learning. Presenting the topic is believed to improve personal and public

accountability (8). Framing questions and replying to the questions raised by the class by the presenter further improved their communication skills and enhanced learning, as proved by other authors (14).

The activity promoted better bonding among the students and also among the students and teachers. It brings all the students close to each other, even those who would not otherwise share any rapport with each other. This is very well evident by their open ended responses like "*It's a healthy way to interact with classmates.*", "*I could relate to my class mates better now.*"

The jigsaw method requires each student to be an instructor as well as an auditor. As quoted by Lom (2012), this activity is a blend of independent acquisition of expertise followed by collaborative teaching (9). The jigsaw method requires each student to be an instructor as well as an auditor. As quoted by Lom (2012), this activity is a blend of independent

acquisition of expertise followed by collaborative teaching (11).

The feedback from the students revealed the Jigsaw method to be a healthy way of interacting with peers; making learning interesting & effective. They were fairly satisfied by this teaching learning innovation and recommended its use in other topics in Physiology as well.

The original jigsaw learning method was projected to promote cooperation and solidity among students with varied backgrounds (1). In the current scenario, it is advocated to promote collaborative and co-operative peer assisted learning. Co-operative teaching in the form of jigsaw activity has been tried and tested in various educational fields, but less so in the field of medical education. In the medical field, this form of peer-assisted learning was effectively used in learning cardiopulmonary resuscitation (5). The jigsaw technique has been well tested in pharmaceutical sciences; it has shown to improve critical thinking skills regarding drug information and in understanding the concept of renal clearance of drugs (7, 16, 18). The jigsaw technique was also successful in teaching the concepts involved in the clinical controversy and long term and post-acute care to medical students (19, 3).

Nonetheless, literature search could not retrieve any published articles on the use of Jigsaw method for Physiology teaching. However other forms of collaborative teaching, such as peer teaching and

group discussions have been moderately used. The positive feedback from the students has encouraged us to extend this mode of teaching-learning to other topics in physiology as well. The jigsaw learning technique may be an effective way of transforming the medical students from passive to active learners. Such active learning methods are believed to improve critical thinking, problem solving abilities and information retention; thereby fostering lifelong learning skills among medical students. Knowledge, team work and communication skills are keys for being a successful medical practitioner. Thus the present study facilitated the students to comprehend better, improve their analytical abilities and hone their communication skills.

However the limitations of this study are that it was performed on only one topic- '*Mechanics of Respiration*' of Physiology. It would have been sensible, if it was applied to more topics. Also, all the students could not get a chance to present; selecting smaller sub-topics can resolve the issue to some extent.

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