Original Article

Jigsaw teaching as an active learning strategy in large medical classrooms: A quasi-experimental study in pathology

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Abstract

Background & Objective: Teaching was primarily didactic and teacher-centered in ancient India. Medical educators have emphasized the need for active learning strategies to engage the students in large classroom teaching. An extensive literature search revealed only minimal publications on the large classroom jigsaw method. Hence, this study was done to introduce and incorporate the jigsaw method as a technique for large classroom teaching and learning in pathology. Further, it was done to assess its effectiveness in a large classroom setting and see how students perceived this method.

Materials & Methods: A quasi-experimental study without control groups (One group pretest-posttest design) was conducted for 141 MBBS II phase students in a large classroom jigsaw activity from 2023-24. A didactic lecture was taken prior. A pre-test was taken, and the topics for subgroups, study material, and questions were intimated in advance. On the day of the jigsaw activity, students from each group were randomly selected to explain the subtopic to the whole class. Finally, two students were made to summarize. Post-test and feedback were taken, and their validity and reliability were approved. The data was analyzed using descriptive and analytical tests with SPSS Version 20 at a significance level of $P < 0.05$.

Results: The mean marks scored in the post-test was 14.57 ± 3.20 compared to 11.1 ± 3.50 in the pre-test for 20 marks. 89.3% of students scored 50% and above in the post-test. There was a significant performance improvement ($p < 0.001$). In the feedback, 78.7% of students agreed they would like to participate in similar interactive sessions. The highest satisfaction index, 86.73, was for in-depth coverage of topics.

Conclusion: The jigsaw large classroom teaching strategy promotes extensive coverage of topics in a short period and can be used as a tool for revision and knowledge retention in collaborative learning.

Keywords: large classroom teaching, student centered learning, jigsaw, teaching and learning methods.

Introduction

Medical education is an important factor in the progress of any country. Hence, increasing attention is being paid to the quality of teaching and learning in medical colleges [1]. In ancient times, education was primarily didactic and teacher-centered in India. Previously, teachers engaged the class for nearly one hour without giving any break, and they never thought about how much of the subject students could assimilate. However, the setting up of a new Competency-Based Medical Education (CBME) curriculum by the National Medical Council for Indian Medical Graduates has brought a revolution in 2019. Hence, medical educators have stressed the need for active learning strategies to engage the students [2]. Building more inclusive schools is also a primary objective of the international educational guidelines by the United Nations Educational, Scientific and Cultural Organization (UNESCO) [3]. Cooperative learning methods like jigsaw have been highlighted as one of the effective ways to promote active learning strategy in inclusive schools [4, 5]. Collaborative learning is a set of situations in which students interact

and learn. This type of learning has emerged as a promising pedagogy practice in inclusive schools [6, 7].

Jigsaw is a collaborative learning paradigm with a group of students to enhance their critical thinking and to make learning meaningful and engaging [8]. This is a strategy in which students of the class are organized into groups and share what they have learned from peer teaching. Students in the group are expected to master the material assigned to them and discuss it with peers from different groups. The facilitator oversees the discussion and clarifies student misconceptions [9]. The jigsaw method is very popular among teachers as it is easy to follow this structured technique and helps students improve socialization and learning [10].

Aronson et al. originally developed this jigsaw method to reduce intergroup prejudices. Based on his observations, he concluded that intergroup aggressiveness is due to the competitive classroom environment [11]. Since this method creates interactions in which students depend on each other to learn the material, like assembling a jigsaw puzzle, with each member supplying an essential piece, it helps nullify intergroup aggressiveness [12].

An extensive literature search showed that only minimal publications are available on handling large classrooms with jigsaw active learning method [13-15]. There is also a significant gap between scientific evidence favoring the jigsaw method and actual classroom practices. Most articles have shown the historical evolution and application of the jigsaw method in small-group teaching and learning techniques [10]. Hence, the study was done to incorporate the jigsaw method for large classroom teaching and to see how students perceived this method. Here, we have aimed to know the effectiveness of the jigsaw method in collaborative learning and knowledge retention in a Large Classroom setting for MBBS phase II medical students studying pathology. This will inevitably help us save resources such as time and workforce and know how students perceive this method.

Materials & Methods

Design and setting(s)

A quasi-experimental study design without control groups (one group pre-test and post-test design) was conducted in the department of pathology of a reputed medical college. A single pre-test measurement was taken, an intervention was implemented, and a post-test measurement was taken. In this study, the pre-test frequently serves as the "control" [16]. A quasi-experimental study was done without a control group as the student population is vulnerable, and randomization cannot be done due to ethical considerations. It was also challenging to randomize the students of the selected class as it was impossible to prevent the intervention group from interacting and sharing study material with the control group [16, 17]. The class was planned to use the jigsaw method with a student-centered teaching approach for medical students in phase II (batch of 150 students).

The objective of this study is to introduce and incorporate the jigsaw method as a technique for large-classroom teaching and learning in pathology. Further, it will assess its effectiveness in a large classroom setting and see how students perceive this method.

Participants and sampling

As students are a vulnerable population, we considered all phase II MBBS students studying at KLE JGMM medical college for this study. We adopted the universal sampling technique, which means the total population of phase II MBBS will be the sample size [18]. With an assumption of $\alpha = 0.05$, the required sample size of 67 cases was obtained using Minitab16 software. Out of 150 students of Phase II MBBS, 141 students were included in the present study after considering inclusion and exclusion criteria.

Inclusion criteria: Students pursuing their phase II MBBS course in the college during 2023-24.

Exclusion Criteria: Students on leave due to illness or other personal reasons for the didactic lecture or jigsaw classroom activity (**Figure 1**).

Tools/Instruments

Multiple-Choice Questions (MCQs) for the pre-test and post-test were prepared on the topic (objective assessment) in the form of google forms, which comprised 20 questions. Expert scores were used to achieve content validity of MCQs. To check content validity, ten faculty members (5 faculty who were facilitators for the jigsaw classroom teaching and five other faculty who were not a part of the study) from the department of pathology, JGMM medical college, were given to express their opinions and questions were modified accordingly. Questions with a Content Validity Ratio (CVR) of more than 0.62 were retained.

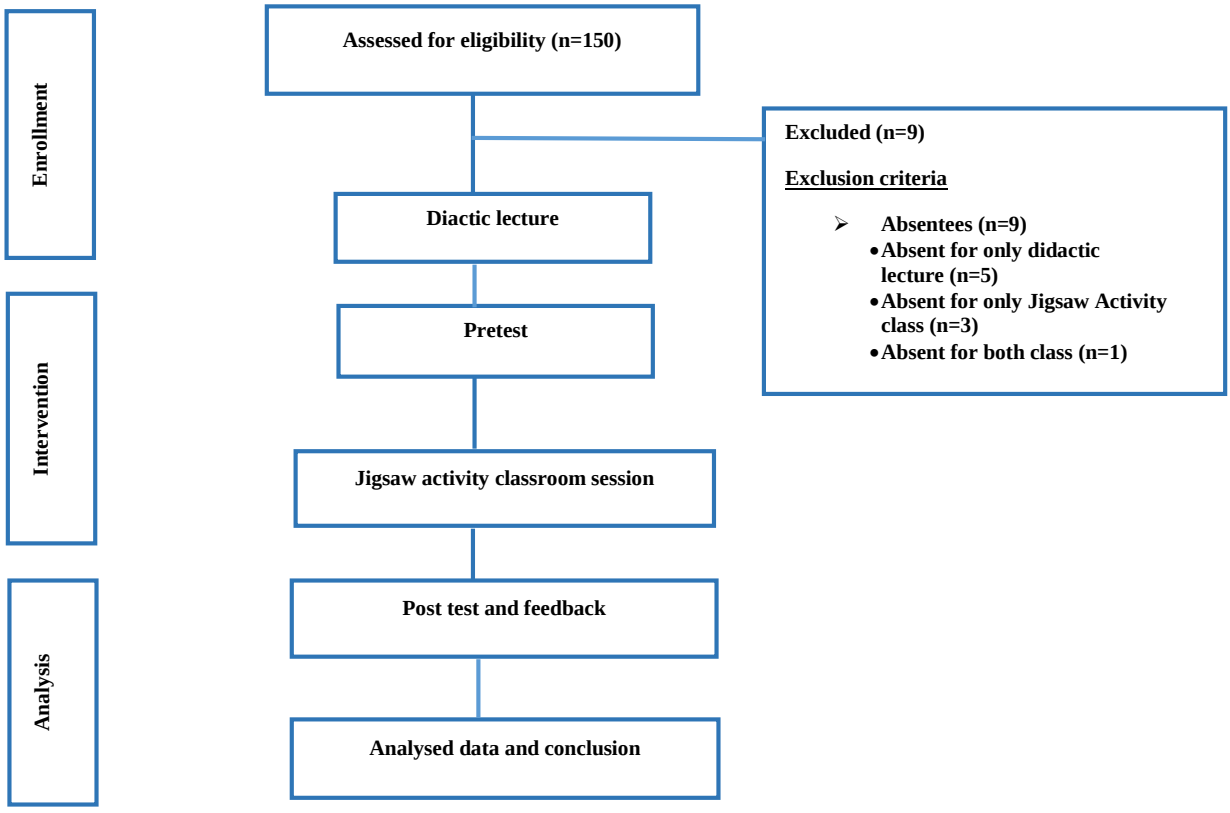

Figure 1. The flow diagram of the study

The relevance of the questions was also maintained with a Content Validity Index (CVI) of higher than 0.79 [19]. In this study, the CVI of entire multiple-choice questions was 0.95. For each correct answer, the student was awarded one mark and zero marks if the answer was incorrect.

A feedback questionnaire of 14 questions was prepared based on five 5-point Likert scales (1 = strongly disagree, 2 = disagree, 3 = neural, 4 = agree, 5 = strongly agree) to assess students' perception of the jigsaw technique [14]. A pilot study on 25 students was conducted previously using the jigsaw technique on transfusion reaction. The pilot study was used to check the face validity of the feedback questionnaire based on the students' opinions on the writing style, vocabulary, and quality of the questions. Additionally, faculty members did content validity to validate the feedback questionnaire, like in the case of multiple-choice questions. The reliability of the feedback questionnaire was measured using Cronbach's alpha coefficient [20-22]. Cronbach's alpha for each item in the questionnaire was 0.94. Cronbach's alpha value between 0.90 and 0.95 is desirable [23]. gross specimens, instruments, and models related to pathology (university CBME curriculum) were used as tools for conducting this jigsaw classroom activity [24].

Data collection methods

The study was conducted at the department of pathology at KLE's JGMM medical college. Ethical clearance was obtained before the study. A didactic lecture was conducted before the jigsaw classroom activity, which included a briefing about all the gross specimens, instruments, and models related to pathology in the form of a PowerPoint presentation (university CBME curriculum) [24].

The consent form for the study was obtained from students before the jigsaw activity was conducted. Pre-test MCQs were given using google forms. Ten minutes were given, and responses were collected. The topics related to practical examination were chosen. The subtopics were instruments, specimens, and path-pantry models. These subtopics were to be described and discussed. The students were given the study material before the class. The participants were divided into three subgroups based on their roll numbers: Group A (roll numbers 1-50) focused on instruments, group B (roll numbers 51-100) worked with gross specimens, and

Group C (roll numbers 101-150) concentrated on pathology models, as illustrated in **Figure 2**. Each group was tasked with preparing material on one of the designated subtopics. Then, one student from the respective subgroups was selected to form a group of 3, and they were asked to discuss, teach, and learn among themselves. This exercise was done to train the students to face the viva voce confidently in the examination and as a part of a quick revision.

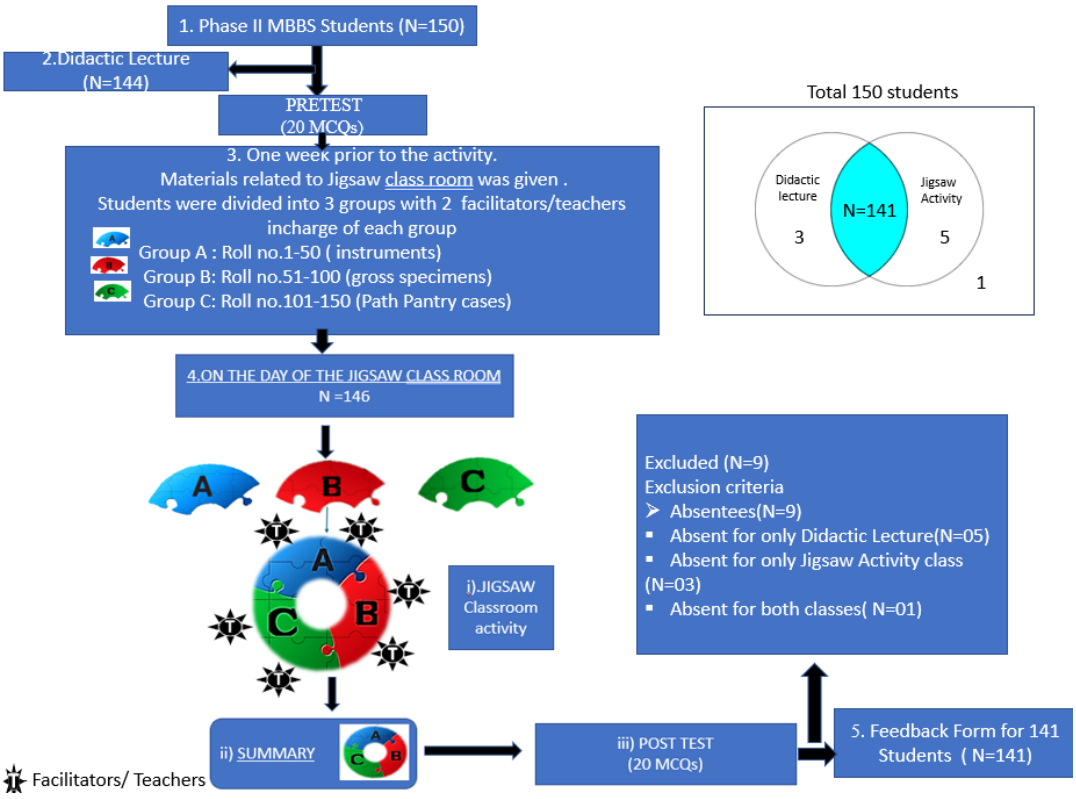

Figure 2. Flow chart of the study using jigsaw method

On the day of the jigsaw activity, students from these subgroups were randomly picked to present the description of the instruments, gross specimens, and path- pantry models. Wherever they had difficulty, the teachers acted as facilitators and helped their respective groups of students present the description. The teachers also resolved any misconceptions and doubts among students. The students enthusiastically described their subtopics and answered the questions already given them. The discussion was conducted for 60 minutes. Finally, two students were randomly picked to summarize what they had learned in 15 minutes. Post-test and feedback were taken after the jigsaw classroom session in 15 minutes. The reliability of the feedback questionnaire was measured by Cronbach's alpha coefficient [20, 21]. Feedback was taken regarding student engagement, concepts, depth of coverage of topics, etc., and overall activity conduct. Pre-test, post-test, and feedback forms of 141 students were analyzed for the study after excluding the students as per the exclusion criteria. The jigsaw activity was applied during the tutorial, spanning 1 hour and 30 minutes. Previously, the same technique was used in the class on transfusion reaction as a pilot study.

Data analysis

The data was collected through pre-test, post-test, and feedback forms. It was analyzed using SPSS version 20 software, which used descriptive statistics (percentage, mean, and standard deviation), a satisfaction index, and a paired t-test. A p-value < 0.05 was considered statistically significant in the hypothesis test.

Results

On the day of the jigsaw classroom activity, 141 students participated in the pre-test and post-test, and 6 faculty members were present as facilitators.

The classroom strength was 94% (141/150), higher than the average attendance over the past three months (85.6%). It was observed that the mean mark scored by the students in the pre-test conducted out of 20 marks was 11.1 ± 3.50, and in the post-test was 14.57 ± 3.20. In the pre-test, 71.6% (n =101) of students scored 50% (10 marks) and above. In the post-test, 89.3% (n = 126) of students scored 50% (10 marks) and above. 17.7% (n = 25) of students have improved after the jigsaw puzzle classroom activity. There was a significant improvement in performance with a p-value of < 0.001. (**Table 1** and **Figure3**)

The same topics were earlier covered in the syllabus by Didactic lectures and practical classes, but after the jigsaw classroom session, knowledge significantly improved. 56.7% of students preferred lectures with an active learning strategy, whereas 43.3% still favored only didactic lectures (**Figure 4**).

Table 1. Comparison of Pre Test and Post Test Score of Students (n=141)

	Marks scored (Mean ± SD)	p-value
Pre-test	11.1 ± 3.50	< 0.001
Post-test	14.57 ± 3.20	

Note: Paired t-test was employed to compare the mean score of Pre-test and Post-Test.
Abbreviations: SD, standard deviation; p-value, probability value.

The Satisfaction index for each question was calculated using the formula [14]:

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

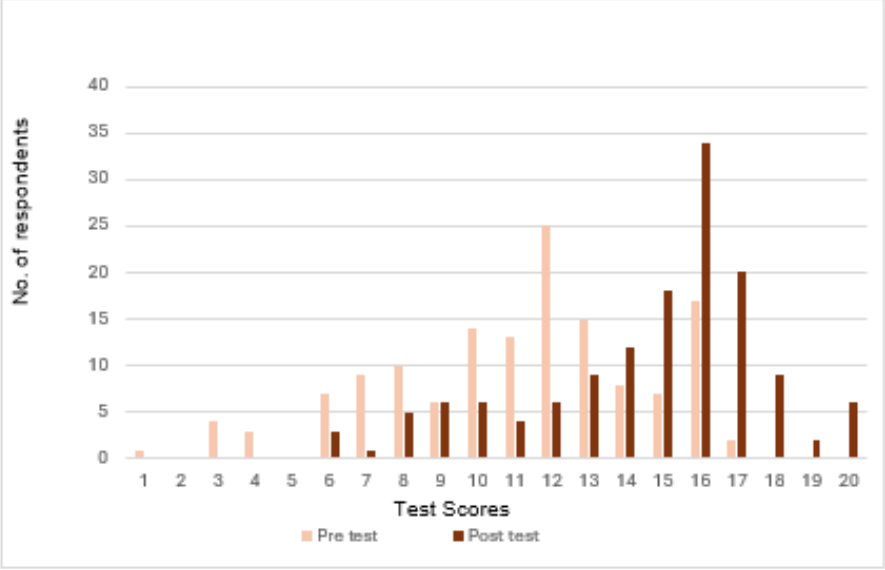

Figure 3. Comparison of pre-test and post-test scores

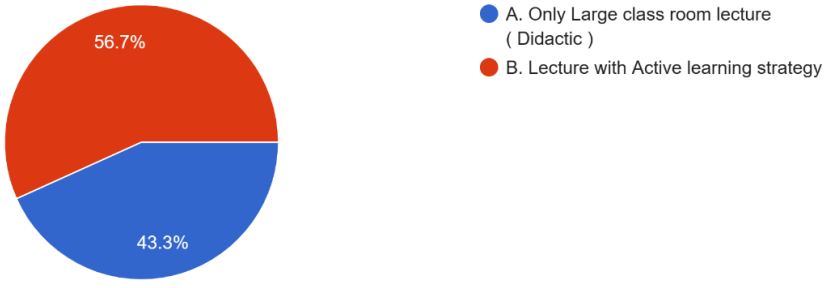

Figure 4. Feedback response by the students on preferred methodology of teaching

The scores were rated on a 1–100 satisfaction index scale [14]. Calculated scores for different questions are shown in **Table 2.** The highest satisfaction index, 86.73, was for in-depth coverage of the topics, and the lowest index was for Concept attainment (85.10).

About 66.6% of students opined that the jigsaw classroom teaching and learning method achieved in-depth coverage of the topic. 65.25% of students agreed that the concepts were well explained, and 70.9% of students agreed that the facilitator engaged them to participate actively in the activity.

Table 2. Satisfaction index calculated from the feedback form.

SN.	Questions	Strongly disagree (1)	Disagree (2)	Uncertain (3)	Agree (4)	Strongly agree (5)	Satisfaction index
1	Facilitator engaged the participants	4	3	34	51	49	85.79
2	The concepts were explained well	3	1	45	53	39	85.83
3	This activity helped to achieve in depth coverage of the topic	3	1	43	50	44	86.73
4	This activity was useful in attaining the concept (In depth learning)	3	3	43	52	40	85.10
5	The activity was interactive	4	3	38	51	45	85.24
6	Concepts were explained with suitable examples	3	4	40	45	49	86.33
7	AV aids were used effectively	2	4	43	46	46	86.53
8	The time was managed effectively	2	6	46	39	48	86.31

Abbreviations: AV, Audio Visual ; SN., Serial Number.

68.08% of students found this active learning session very interactive. The majority of the students (78.7%) agreed that they would like to participate in similar interactive sessions in the future.

Most of the students (61.7%) opined that the time allocated for the session was well managed. 65.2% of the students perceived the use of audiovisual aids as well.

61% of students opined that the jigsaw active learning strategy helped them gain knowledge regarding the topics, but only 27.7% of students felt that this teaching technique helped them solve problems related to the topic.

When asked about the drawbacks of jigsaw puzzles, a good number of students (47.5%) were of the opinion that not referring to the study material hindered their learning process, hence substantiating the importance of preparing for the class beforehand by using the study material.

Discussion

The students received the jigsaw method very well. They developed a strong sense of responsibility toward this active learning technique. They took it as an opportunity to teach and learn from their fellow students. They were positive about the jigsaw method as it helped them improve their communication skills, which would help them for the final viva voce. They also learned empathetic listening and speaking confidently. Overall, it boosted the atmosphere of increased collaboration in which students worked in groups and helped each other towards a common goal [25].

In this study, we measured the effectiveness of the jigsaw method by testing their knowledge retention. The post-test scores were significantly higher, with a p-value of < 0.001, indicating that knowledge retention is more significant with the jigsaw method. This result is similar to earlier studies done by Krishna et al. [15], Chauhan et al. [25], Gowda et al. [26], Lalit et al. [27] and Ng et al. [28]. In all these studies p-value was significant, therefore proving jigsaw method of teaching students in large classroom setting is equally effective as, teaching students in small group setting and it enhances knowledge retention also. The students took the Jigsaw method positively, and 68.08% of students agreed that it enhances peer interaction. Also, 65.25% of students agreed that it helped them understand the topic and attain

the concepts. This was similar to the study by Chauhan et al., in which 91% of students agreed that it enhances peer interaction, and 90% of students agreed that it helped in deeper learning of the topic [25]. A study by Gowda et al. states that 54% of students agree that the jigsaw method helped them understand the topic better, and 52% strongly agree that the session helped them improve interpersonal communication skills [26].

In our study, 56% of students enjoyed the jigsaw classroom method and preferred it over the didactic lecture, which was similar to the study done by Gowda et al. [26] and Lalit et al. [27]. Hence, it is proved that students well perceived it.

Our students (27.7%) felt that this technique of teaching helped them in problem-solving related to the topic, which was less compared to other studies like Pahwa et al. [29] and Bhandari et al. [14]. This is probably due to the type of topic which was chosen for students to describe for this activity. On the day of the jigsaw puzzle classroom activity, a few students were absent randomly from each group, creating bias. This can be minimized by doing multiple sessions with the same students and different topics over a year. Another limitation of our study is that no control group was available for comparison due to ethical issues. Therefore, a quasi-experimental study was conducted in which keeping a control group was not mandatory. There are many studies in literature where they also carried out quasi-experimental studies without any control group. Hence, it is not a significant bias factor [16, 17].

The highest satisfaction index of 86.73 was for in-depth coverage of the topics, which was similar to the study done by Bhandari et al. [14]. In spite of applying the jigsaw technique to a larger group, the results were fruitful, and more information was delivered in a short period of time. In the study done by Pahwa et al., students felt that this method was time-consuming [29]. Sharma et al. implemented this method among 150 students in 3 hours [30]. Also, in a study by Uppal et al., the jigsaw learning method was undertaken in two different batches on four different days, with faculty and senior residents acting as facilitators [22]. This method saved much time and human resources in our study, as it was completed in 1 hour and 30 minutes. 78.7% of the students agreed that they would like to participate in similar interactive sessions in the future. Studies have shown that students learn more when they work in groups. Through group activities, they learn how to work in collaboration to improve their academic knowledge and interpersonal skills [22, 31].

Conclusion

This article describes using the jigsaw technique as a large classroom teaching strategy that promotes extensive coverage of topics in a short period. Hence, jigsaw activity for large classroom teaching is a good tool for revision and knowledge retention in the form of collaborative learning.

Ethical considerations

This study was registered in the Institutional Ethics Committee of KLE JGMMMC, Hubli, with code JGMMMCIEC/044/2023. The students who participated gave written informed consent, and their information was kept confidential.

Artificial intelligence utilization for article writing

Not applicable.

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Conflict of interest statement

No conflict of interest.

Author contributions

The contributions of the authors to the study are as follows: Ganga S. Pilli developed the study idea, designed the study, and contributed to the review, interpretation, and editing of the manuscript. Madhuri Dindalkoppa prepared the manuscript, collected data, and assisted in the review and editing process. Prajna K. S. helped in manuscript preparation and contributed to its review and editing. Shivani S. Rao was responsible for data collection and analysis, as well as interpretation, review, and editing. Vivek V. Mannammanavar focused on data collection, while Priyanka S. Murgod contributed to developing the study idea and its design.

Supporting resources

Not applicable.

Data availability statement

The corresponding author can provide the datasets analyzed in this study upon reasonable request, as doing so would compromise the privacy of the participants.

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