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Research Article

Optimizing Small Group Learning: A Comparative Study of Jigsaw Technique and Case-Based Learning Methods in Medical Education

Geeta Yadav[1], Sandeep Bhattacharya[2], Shuchi Agrawal[3], Rajni Patel[4], Manish Kumar[5], Shalini Bhalla[6], Riddhi Jaiswal[7]

[1,5,6,7]Department of Pathology, King George's Medical University, Lucknow, Uttar Pradesh, India
[2]Department of Physiology, King George's Medical University, Lucknow, Uttar Pradesh, India
[3]Department of Obstetrics & Gynecology, King George's Medical University, Lucknow, Uttar Pradesh, India
[4]Department of Anatomy, Virangana Awantibai Autonomous State Medical College, Etah, Uttar Pradesh, India

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Corresponding Author:
Geeta Yadav, Department of Pathology, King George's Medical University, Lucknow, India
E-mail Id:
drgeetayadav6@gmail.com
Orcid Id:
https://orcid.org/0000-0001-8193-8436

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A B S T R A C T

Introduction: Active learning techniques like Case-Based learning (CBL) and Jigsaw Learning are effective small-group learning methods. They promote higher-order cognitive skills and improved collaboration. Both are more effective than didactic lectures. The study aims to conduct a comprehensive comparison of these techniques in terms of their impact on knowledge retention, the development of clinical reasoning, and overall student satisfaction.

Material & Methods: Sixty postgraduate medical students from the Department of Pathology at King George's Medical University were randomly assigned to CBL or Jigsaw learning. Learning outcomes were measured through pre-test and post-test scores, and student perceptions were assessed using a 5-point Likert scale.

Results: CBL demonstrated significant improvement in scores, with a mean pre-test score of 7.7 ± 2.33 and a post-test score of 11.3 ± 1.84 ($p = 0.000$). Jigsaw learning also showed substantial improvement, with pre-test scores of 8.53 ± 3.03 and post-test scores of 12.90 ± 2.52 ($p < 0.000$). Jigsaw learning slightly outperformed CBL in terms of student performance ($p = 0.002$). Regarding perceptions, 95.5% of students strongly agreed that Jigsaw learning was enjoyable, with a mean score of 4.95. Other aspects, such as ease of understanding, had a mean score of approximately 4.77, while only 63.6% found it beneficial for memory retention.

Conclusion: Jigsaw learning was more effective than CBL in post-test performance, underscoring its ability to foster a deeper understanding through collaboration. However, both methods faced challenges regarding time consumption and memory retention, suggesting a need for refinement and better integration in medical curricula.

Keywords: CBL, case-based learning, Jigsaw, peer-assisted, didactic, lecture

Introduction

Medical education is constantly evolving to meet the demands of an increasingly complex healthcare environment. While still relevant, traditional lecture-based learning is often criticized for its passive nature, which can limit student engagement, critical thinking, and long-term retention of knowledge. Active learning strategies have gained traction, fostering a more profound understanding, enhanced problem-solving abilities, and increased student collaboration. Among these strategies, Jigsaw Learning and Case-Based Learning (CBL) are effective methods, particularly in small-group settings.[1,2] However, despite their growing adoption, there remains a gap in understanding their relative effectiveness, particularly in enhancing diagnostic reasoning, critical thinking, and long-term retention of medical knowledge. The Jigsaw Technique is a peer-assisted cooperative learning strategy that divides a class into small groups, with each member responsible for mastering and teaching a specific portion of the assigned material to their peers. This method fosters active engagement, collaboration, and a deeper understanding of the subject matter. Students are initially divided into "home groups" and then reassigned to "expert groups" where they specialize in a specific topic. After mastering their portion, they return to their home groups to teach their peers. This approach fosters accountability, teamwork, and the development of practical communication skills, all of which are essential for medical professionals.[3,4] Case-based learning is an instructional strategy that uses real-life or simulated patient cases as a foundation for learning. CBL encourages students to apply theoretical knowledge to practical scenarios, fostering critical thinking, problem-solving skills, and the integration of interdisciplinary knowledge. In a typical CBL session, students work collaboratively to analyze a patient case, identify key issues, and develop diagnostic and treatment strategies. This method aligns closely with clinical practice, helping students bridge the gap between theory and real-world application.[5,6]

While Jigsaw learning and CBL are widely utilized in medical education, there is limited comparative research on their relative effectiveness within small-group learning contexts. Previous studies have independently explored these methods, demonstrating their benefits in enhancing student engagement, fostering collaboration, and facilitating the application of knowledge.[7,8] However, a comprehensive comparison between these techniques, particularly regarding their impact on knowledge retention, the development of clinical reasoning, and overall student satisfaction, remains underexplored. A deep understanding of the comparative effectiveness of these methods could inform faculty decisions in curriculum design and pedagogical strategies, ensuring that medical students receive the most effective educational experiences. Moreover, it could help educators optimize the allocation of limited teaching resources by selecting the most effective strategy for specific learning objectives. The study aimed to compare the effectiveness of jigsaw learning and case-based learning (CBL) in acquiring knowledge, developing critical thinking skills, and enhancing collaboration abilities, as well as to assess students' perceptions of jigsaw learning versus CBL.

Materials and Methods

This was a prospective interventional study conducted on 60 postgraduate students in the Department of Pathology, King George's Medical University, Lucknow, between August 2024 and December 2024. Students who were absent or did not provide consent were excluded from the study. Informed written consent was taken from all the participants. The Institutional Ethical Committee approved the study (137th ECMIIA/P9). The participants were randomly assigned to two groups, each consisting of 30 students, for the CBL and Jigsaw Learning methods. Group allocation was carried out using simple random sampling through the lottery method.

Case-Based Learning (CBL)

For CBL, the facilitator taught the students using a case-based scenario to enhance their understanding and application of the topic. The topic selected for CBL was hemostasis and the approach to bleeding disorders. Knowledge and critical thinking gained by the students was assessed through pretest and post-test questionnaires consisting of twenty multiple-choice questions (MCQs).

Jigsaw Learning

The jigsaw learning group consisted of 30 students divided into five home groups, each comprising six students. The topic was divided into six subheadings in each home group. Each student was given a detailed sheet containing information about their specific portion of the subject and references for further study, the day before the class. The topic for the study was thrombophilia. Students initially assembled in their home groups on the day of the session. Then, they were reorganized into expert groups (having similar subheadings from each home group) to discuss and exchange ideas on their assigned subtopics for 20 minutes. The discussion was supervised and facilitated by the teacher. Following this, each expert group member returned to their respective home groups to teach the portion assigned to them to their peers (Figure 1).

The session concluded with a discussion of the topic, and an assessment was conducted using twenty multiple-choice

questions (MCQs) to evaluate students' understanding. Pretest and post-test scores were recorded to measure learning gains. These MCQs included theoretical and problem-based questions to assess students' knowledge and analytical skills and were pre-validated by two other faculty members from the department. The perception of all the students toward CBL and Jigsaw learning was assessed using a 5-point Likert scale to gauge their satisfaction and learning experience. The same teacher conducted all the sessions to maintain consistency.

Statistical Analysis

The completed response sheets were collected on Google sheets and statistically analyzed to compute the results using Microsoft excel and SPSS version 21. Qualitative data were expressed as percentages, and quantitative data were expressed as the mean ± standard deviation. A paired "t" test was used to compare pretest and posttest scores and expressed in terms of the "p" value. Post-test scores were analyzed using the student t-test to compare the difference between CBL and jigsaw learning. The value of $p<0.05$ was considered statistically significant.

Results

Sixty postgraduate students participated in the study, with thirty in each of the CBL and Jigsaw learning groups.

Case-based learning

The pretest mean score for CBL was 7.7 ± 2.33, while the post-test mean score improved to 11.3 ± 1.84. A paired t-test revealed a significant improvement in student performance after CBL ($p < 0.000$). Notably, 93% of students demonstrated improvement, whereas 7% did not.

Students' perception of the CBL was assessed on a Likert scale. Table 1 shows students' perceptions of CBL. Among 30 participants, 94.7% (28 students) strongly agreed it was interesting, with a mean score of 4.95. Easy understanding and doubt clarification both had a mean score of 4.74, while clinical understanding was rated at 4.79. Comfort with the facilitator and overall effectiveness were both rated 4.84. However, memory retention received a slightly lower mean score of 4.63. These findings suggest that students found CBL to be highly engaging, effective for learning, and beneficial in clinical applications, although its impact on memory retention was comparatively lower. (Table 1)

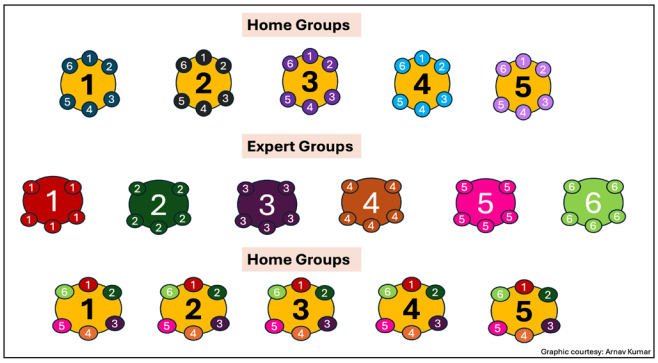

Figure 1. A diagrammatic representation of the formation of jigsaw home groups & expert groups

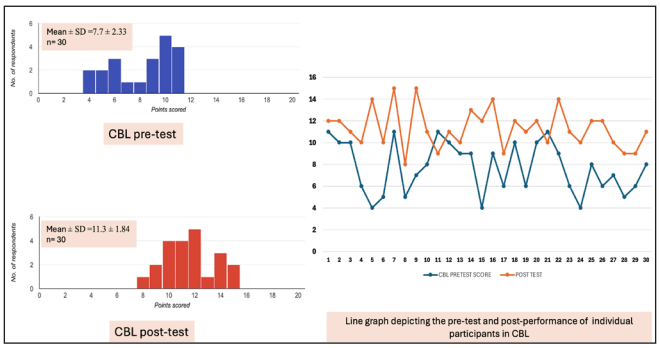

Figure 2.shows a bar diagram of the mean scores of participants' pre-test and post-test after the CBL

Table 1.Students' perception of the Case-based learning

		Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	Mean
1	Interesting	0	0	0	2	28	4.95
2	Easy understanding	0	0	0	8	22	4.74

3	Doubt clarification	0	0	2	5	23	4.74
4	Comfortable with facilitator	0	0	0	5	25	4.84
5	Memory retention	0	0	2	8	20	4.63
6	Clinical understanding	0	0	0	6	24	4.79
7	Overall effectiveness	0	0	0	5	25	4.84

Among 30 students, 94.7% found CBL interesting, 84.2% were comfortable with the facilitator, and 84.2% considered it effective. Additionally, 78.9% felt it helped clarify doubts and improve clinical understanding, while 73.7% found it easy to grasp. However, only 68.4% believed it was beneficial for memory retention (Figure 3).

Jigsaw Learning

The mean test scores for jigsaw learning, as measured by the pre-test and post-test, were 8.53±3.03 and 12.90±2.52, respectively. A paired t-test revealed a significant improvement in student performance after the jigsaw ($p = 0.000$). Similarly, 93% of students demonstrated improvement, whereas 7% did not. Figure 2 shows the bar representation of the mean of the pre-test and post-test of Jigsaw, along with a line graph representation of the comparison of scores of individual participants. (Figure 4)

Students' perceptions of jigsaw learning were also assessed for the same seven points as CBL. Among 30 participants, 95.5% (29 students) strongly agreed it was interesting, with a mean score of 4.95. Easy understanding, doubt clarification, and clinical understanding all had a mean score of 4.77. Comfort with the facilitator and overall effectiveness was rated 4.86, showing strong approval. However, memory retention received the lowest mean score of 4.55. These results indicate that students found Jigsaw learning highly engaging, effective for understanding concepts, and beneficial for clinical application. However, its impact on memory retention was slightly lower than other aspects. (Table-2)

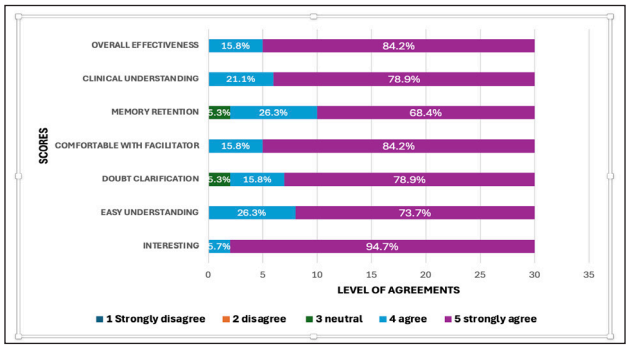

Figure 3.Diagrammatic representation of students' perception of CBL

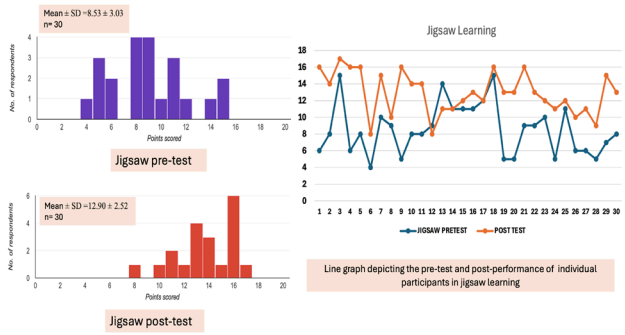

Figure 4.compares the mean scores of the pre-test and post-test, presenting a line graph of individual participants' scores

Table 2.Students' perception of the Jigsaw learning

		Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	Mean
1	Interesting	0	0	0	1	29	4.95
2	Easy understanding	0	0	0	7	23	4.77
3	Doubt clarification	0	0	0	7	23	4.77
4	Comfortable with facilitator	0	0	0	4	26	4.86
5	Memory retention	0	0	3	8	19	4.55
6	Clinical understanding	0	0	0	7	23	4.77
7	Overall effectiveness	0	0	0	4	26	4.86

Among 30 students, 95.5% found jigsaw learning interesting, and 86.4% were comfortable with their peers and considered it effective. Additionally, 77.3% felt that it helped clarify doubts, improved their clinical understanding, and made it easier to grasp. However, only 63.6% believed it was beneficial for memory retention. (Figure-5)

Comparison of Jigsaw Learning Versus CBL

The mean post-test score for CBL was 11.3, with a standard deviation of 2.53, while Jigsaw had a higher mean score of 12.9, with a standard deviation of 3.53. The paired t-test revealed a significant improvement in both methods, with t-values of -7.67 for CBL and -6.76 for Jigsaw, achieving a p-value of 0.00. The difference between the post-test scores of the two methods was statistically significant (p = 0.002), indicating that Jigsaw was more effective in enhancing student performance. (Table-3)

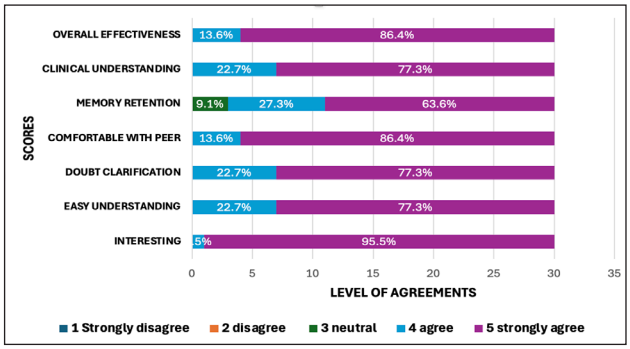

Figure 5.Diagrammatic representation of students' perception of Jigsaw learning

Table 3.Comparison of case based learning versus jigsaw learning

	Number of participants	Mean of post test	Standard Deviation	"t"	significance	Pair significance
CBL	30	11.3	2.53	-7.67	0.00	p=0.002
Jigsaw	30	12.9	3.53	-6.76	0.00	

Discussion

Active learning strategies shift the focus from passive reception of information to active participation, where students engage in discussions, problem-solving, and applying their knowledge. These approaches have been shown to enhance learning outcomes by promoting higher-order cognitive skills, fostering collaboration, and improving retention rates. [1,9] Active learning techniques are particularly valuable in medical education, where students must integrate vast theoretical knowledge with clinical application. However, the successful implementation of these methods is often hindered by several barriers, including:

- Faculty Shortages – There is a shortage of trained faculty members who are willing and equipped to facilitate active learning sessions.

- Time Constraints – Medical curricula are often packed, leaving little room for additional interactive learning activities.
- Resource Limitations – Effective active learning requires adequate resources, including well-structured cases and teaching aids.
- Resistance to Change – Both students and educators may resist departing from traditional lecture-based instruction.[10, 11, 12] Despite these challenges, active learning methods such as Jigsaw Learning and CBL have been successfully integrated into many medical programs, demonstrating their feasibility and effectiveness.

The findings revealed significant improvements in knowledge acquisition and student perception across both methods, with Jigsaw learning demonstrating a slight edge in enhancing student performance. The pretest and post-test scores for both learning strategies showed statistically significant improvement, confirming their effectiveness in facilitating student learning.

Case-based learning enhances learning by promoting the development of applied reasoning skills and fostering higher-order thinking. It facilitates a deeper understanding of conceptual knowledge, enabling students to use it effectively in various cases and contexts. It encourages students to think like clinicians, integrating knowledge into real-world scenarios while engaging students in diagnostic reasoning and decision-making through active participation.[13,14] It also stimulates a multidisciplinary approach towards cases. Research by Cen XY et al. (2021) and Thistlethwaite et al. (2012) highlights that CBL is highly effective in fostering critical thinking, stimulating interest, and encouraging a team-based approach to problem-solving in clinical settings. [(16, 17)] However, specific challenges exist, including the availability of trained facilitators, well-developed case studies, and standardization. Studies by Thurman et al. (2009) and Choi et al. (2009) indicated that students' learning styles did not significantly impact their perceived learning experiences with CBL. [(18,19)]Studies by Swathi A. et al. 2017 demonstrated that the Jigsaw teaching method enhanced teamwork and interpersonal communication and fostered thinking and problem-solving skills. [20] Similarly, an evaluation of the Jigsaw method using the Kirkpatrick evaluation framework, carried out by Vinod Kumar et al. (2017, found it to be an effective teaching-learning tool with a positive impact on students' learning outcomes. [21] Eachempati et al. reported that students in the experimental group (Jigsaw) achieved tremendous success attributed to the collaborative nature of the Jigsaw method, where students actively supported one another and engaged in a more extensive exchange of information compared to their experience in traditional teacher-centered lectures. [22] Bertucci et al. found that cooperative learning led to higher academic achievement and increased peer support compared to individualistic learning methods.[23] Similarly, Sanaie et al. reported that the Jigsaw technique enhanced students' self-regulated learning and academic motivation.[24] Additionally, Walker et al. described the Jigsaw method as an educational and enjoyable approach to peer teaching.[25] However, most of the studies reported in the literature have evaluated the effectiveness of jigsaw

against conventional didactic lectures, and none of the studies have compared its effect against the CBL. The pretest and post-test results demonstrated significant improvements in both groups, with a higher mean post-test score observed for the Jigsaw group (12.9) than for the CBL group (11.3). This suggests that the Jigsaw method, which incorporates peer collaboration and active participation, may have a slight edge in facilitating deeper learning and understanding. The correlation values for Jigsaw (0.201) also indicate stronger engagement than CBL (0.062), suggesting that students were more engaged with Jigsaw learning. This finding indicates that the peer-assisted cooperative learning approach is more effective in enhancing students' understanding of the subject matter. Jigsaw learning fosters active engagement by encouraging participants to participate actively in the teaching and learning process. Additionally, it promotes a sense of responsibility, as students rely on one another to contribute and share their assigned portions of the topic. The method also proves resource-efficient, requiring fewer facilitators to effectively manage multiple groups, making it a practical and impactful teaching-learning strategy.

Our study also captured students' perceptions of both methods using a five-point Likert scale, which revealed no statistically significant difference. However, students expressed that they enjoyed the Jigsaw learning experience during the session. Despite this, they reported challenges with retaining the knowledge gained. Interestingly, Suvarna P. integrated various clinical cases into the Jigsaw learning method in their study and assessed its effectiveness through post-test evaluations, which revealed a significant improvement in knowledge. [26] This highlights the value of hybrid teaching and learning approaches in enhancing educational outcomes.

Contrary to our study, fewer studies have reported the low effectiveness of jigsaw learning. Leyva-Moral and Camps reported low student satisfaction. Most participants felt it was less effective than traditional methods and believed it should not be used in the future. A key concern raised by students was the inability to take notes during the process, which contributed to feelings of insecurity. [27] Lalit M highlighted a significant limitation of the Jigsaw method: its time-consuming nature. The study also emphasized the importance of providing students with prior information

on the topics to ensure they are well-prepared for their assigned portions. [28]Strengths of the Study include a direct comparison between Jigsaw and CBL, adding valuable insight to the existing literature on active learning in medical education, a robust sample size, a uniform facilitator, eliminating potential bias related to teaching style, and a thorough analysis of the effectiveness of both methods.

The study has several limitations, including the time-consuming nature of the methods, particularly Jigsaw learning, which could pose challenges in implementing them within a crowded medical curriculum. Additionally, the study did not assess long-term knowledge retention or account for individual learning preferences, which may affect how effectively each method benefits different students.

Conclusion

Jigsaw's peer-driven, collaborative nature is more effective in promoting a more profound understanding. However, both CBL and jigsaw learning faced challenges, particularly in terms of time consumption and memory retention, highlighting the need for further refinement and integration of these strategies into medical curricula. Incorporating hybrid methods and addressing the limitations of each approach could enhance the overall effectiveness of medical education.

Statement and Declaration

The Authors have no conflict of interest to disclose.

Data sharing statement

Data will be made available upon request from the corresponding author.

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