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Original Article

Effectiveness of Conventional & Jigsaw Method of Self-directed Learning and Interactive Lecture in Undergraduate Physiology Teaching – A Comparative Study.

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Abstract

Background: Medical professionals are expected to be lifelong learners, and the contemporary medical curriculum emphasizes learner-centered education with active student participation. The Competency-Based Medical Education framework promotes the use of active learning strategies such as self-directed learning (SDL), problem-based learning, and small group teaching. However, evidence comparing conventional SDL, the jigsaw method of SDL, and interactive lectures in undergraduate physiology remains limited. This study aimed to compare the effectiveness of these teaching–learning methods among first-year MBBS students at Agartala Government Medical College.

Methodology: This educational interventional crossover study was conducted among 150 first-year MBBS students at Agartala Government Medical College from March to August 2025. Students were exposed to interactive lectures, conventional SDL, and the jigsaw method of SDL across cardiovascular (CVS), respiratory (RS), and central nervous system (CNS) modules. Knowledge was assessed using 10-item multiple-choice pre-tests and post-tests. Data were analyzed using paired and unpaired Student's *t*-tests. Standardized effect sizes were calculated using Cohen's *d*. A *p*-value <0.05 was considered statistically significant.

Results: Baseline pre-test scores were comparable across groups ($p>0.05$; $d \leq 0.32$). Post-test scores were significantly higher with the jigsaw method of SDL compared to conventional SDL for CVS (78.47±11.15 vs 71.09±18.77; $p=0.024$; $d=0.48$), RS (84.52±9.16 vs 75.65±15.44; $p=0.002$; $d=0.70$), and CNS (83.26±26.34 vs 60.00±19.79; $p<0.001$; $d=1.00$). Interactive lectures performed better than conventional SDL for CVS (82.89±16.18 vs 71.09±18.77; $p=0.002$; $d=-0.67$) and CNS (71.06±13.87 vs 60.00±19.79; $p=0.002$; $d=-0.65$). Jigsaw method SDL was superior to interactive lectures for RS (84.52±9.16 vs 71.92±16.24; $p<0.001$; $d=0.96$) and CNS (83.26±26.34 vs 71.06±13.87; $p=0.006$; $d=0.58$).

Conclusion: Jigsaw-based self-directed learning is more effective than conventional SDL and interactive lectures in undergraduate physiology teaching, particularly for integrative topics. Its structured cooperative framework produces meaningful educational gains and supports the objectives of competency-based medical education.

Keywords: Teaching Learning Method (TLM); Self-Directed Learning (SDL); Jigsaw method; Interactive lecture.

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Introduction

Medical professionals are expected to be lifelong learners. To encourage this practice, it is mandatory to facilitate the medical students' learning activities defined by themselves. Current medical education in India aims to train the medical undergraduates in a wide spectrum of domains like cognitive, psychomotor and affective domains to develop the curiosity to seek knowledge and to implement it in practice[1].

The Medical Council of India in 2019 implemented competency-based medical education, which requires multiple and continuous assessment of the students and advocates continuous feedback[2]. The Competency-Based Medical Education (CBME) curriculum has been designed to identify outcomes, level of performance and to develop a framework for assessing competencies.

The new curriculum of medical education is learner-centered instead of age old methods of teacher-centered learning. Over the past decades, didactic lectures were the prime modality of teaching medical graduates. The new curriculum demands active participation and engagement of students, for which new modalities of teaching have been introduced. Various active learning methods like self-directed learning, problem-based learning, and small group teaching have been incorporated[3].

Self-directed learning (SDL) is a strategic approach where the learners are responsible for their own learning process. It is one of the effective ways to encourage the active participation of the students. In this form of learning, a problem is constructed for a small group of learners to discuss and derive solutions. These solutions can then be presented to the other groups of students for them to learn. The facilitator is acting as a moderator and supervisor. This approach of learning helps the students to develop communication skills, team spirit, with appropriate interaction and appreciation of the views of the other group members and leadership qualities among the learners[4,5].

There are various methods of self-directed learning. In traditional SDL, students are given a problem, and they are asked to learn by themselves. The teacher plays the role of moderator and supervisor. Another approach is the Jigsaw method. Jigsaw method of learning is a cooperative learning strategy that asks groups of students to become “experts” on different aspects of a topic and then share the knowledge with other members of the group[2].

Currently, in our institution conventional method of SDL is in practice for teaching physiology for undergraduate students. The jigsaw method of SDL will be a new and interesting way to teach and learn Physiology where all the students have to participate actively. Furthermore, no study has been done to compare the effectiveness of the jigsaw method of SDL, conventional SDL and interactive lecture sessions in this institution.

Therefore, the current study was undertaken to compare the effectiveness of Self-directed learning, both traditional and Jigsaw method and Interactive lecture in teaching Physiology among 1st year MBBS students. To compare the effectiveness of the conventional and Jigsaw method of self-directed learning and interactive lecture as a method of Physiology teaching among 1st year MBBS students of Agartala Government Medical College & GB Pant Hospital, Tripura, India.

Methods

Study setting and location

The study was conducted in the Department of Physiology, Agartala Government Medical College & GB Pant Hospital, Tripura, India, a tertiary care teaching institution offering undergraduate and postgraduate medical education under the National Medical Commission–mandated Competency-Based Medical Education (CBME) curriculum.

Study design
This was an educational interventional study with a crossover design, conducted to compare the effectiveness of three teaching–learning methods: interactive lecture, conventional self-directed learning (SDL), and the jigsaw method of SDL.

A structured interval was maintained between successive teaching sessions to minimize immediate learning carryover effects. In addition, each crossover phase involved different physiological systems (CVS, RS, and CNS), thereby reducing content overlap. The selected topics were reviewed by senior faculty members and mapped to the undergraduate syllabus to ensure comparable difficulty levels, learning objectives, and cognitive demand across modules.

Study duration
The study was carried out over a period of six months, from March 2025 to August 2025. Of this, five months were devoted to implementation of teaching–learning sessions and data collection, followed by one month for data compilation, statistical analysis, and interpretation.

Study population
The study population comprised first-year MBBS students enrolled at Agartala Government Medical College & GB Pant Hospital, Tripura, India, during the academic year 2024–2025.

Sample size
A total of 150 first-year MBBS students participated in the study. All eligible students present during the study period were included, making the sample representative of the entire batch.

Sampling technique
A universal sampling technique was employed, wherein all first-year MBBS students admitted during the study period were included. No sampling was performed, as the entire accessible population was studied.

Assessment Tool and Outcome Measures
The assessment instrument consisted of 10-item multiple-choice questionnaires developed in alignment with predefined learning objectives and the undergraduate physiology syllabus. Content validity was established through independent review by three senior faculty members. The MCQs were pilot-tested among non-participating students to assess clarity and difficulty. Item analysis was performed to determine difficulty indices and discrimination values, and only items with acceptable parameters were retained. Internal consistency reliability was assessed using Cronbach's alpha.

For each teaching session, separate but equivalent sets of validated MCQs were used for pre-test and post-test assessments. The questions were matched for content coverage and cognitive level but were not identical, thereby minimizing recall bias.

Study procedure:
All 150 1st-year MBBS students were included in the study. Students were divided into three groups (Gr-I, II & III) according to their roll nos. with the policy of roll no. 1-50 in Gr-I, roll no. 51-100 in Gr-II & roll no. 101-150 in Gr.-III. At first, students of Group I were assigned to attend a lecture class on a given topic of Physiology. Gr.-II participated in a conventional SDL session. Gr-III attended the Jigsaw method of SDL. Similarly, 3 different topics with crossover amongst the groups were covered. Informed consent was taken from all the study participants. Topic based Pre-test and post-test analysis of the scores of three groups was done. The same set of questions was used for analysis in all three teaching methods. Analysis was done in the form of MCQs of 10 marks. The results of pre-test and post-test for both the interactive lecture class and SDL were analyzed and compared using SPSS software.

Lecture class: Each lecture class lasted for 40 minutes and was made as interactive as possible. Assessment of the lecture session was done by pre-test and post-test MCQs (Multiple Choice Questions). For the pre-test, students were asked to fill in their answers to 10 MCQs in 10 minutes in a Google sheet before the session. In the post-test session, students were asked to answer 10 MCQs in 10 minutes. The MCQ assessments were done online using Google form and scores were released immediately at the end of the class. No negative marking was done.

Conventional SDL session: For the implementation of a conventional SDL session, all 50 students were given the topic to study by themselves for 40 minutes after having a pre-test. At the end of 40 minutes, students were assessed in a post-test session similar to the interactive lecture classes.

Jigsaw method of SDL: For the Jigsaw method of SDL, 50 students were divided into five groups according to their roll numbers and each group consisting of 10 students were monitored by a facilitator during the session. The assigned topic was divided into 10 subtopics. In every group, each student was given one subtopic to study for 10 minutes. Group members then joined members of other groups assigned to the same subtopic to form expert groups with the goal of becoming experts in the topic for the next 10 minutes. The facilitator facilitated the group movement and discussions. Finally, students returned to their original groups. For the next 20 minutes, they taught each other about their specific reading material. Methods of assessment of SDL sessions were similar to those of traditional lecture classes.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0. Continuous variables were summarized using descriptive statistics and expressed as mean ± standard deviation (SD). Normality of score distribution was assessed prior to inferential analysis and was found to be acceptable for parametric testing.

For within-group comparisons of pre-test and post-test scores following each teaching–learning method, the paired Student's *t*-test was applied. For between-group comparisons of mean scores across different teaching–learning methods (jigsaw method of SDL, conventional SDL, and interactive lecture), the unpaired Student's *t*-test was used.

Although the study employed a crossover design, paired and unpaired Student's *t*-tests were used for primary analysis, as each phase involved distinct content domains and independent assessment periods. Repeated-measures analysis was not applied due to the limited number of repeated observations; however, future studies may consider mixed-effects or repeated-measures ANOVA models to account for within-subject variability.

In addition to statistical significance testing, standardized effect size (Cohen's *d*) was calculated for post-test comparisons to assess the magnitude of educational impact independent of sample size. Cohen's *d* values were interpreted as small (≈0.2), moderate (≈0.5), and large (≥0.8). A two-tailed p-value < 0.05 was considered statistically significant for all analyses.

Standardized effect sizes were calculated using Cohen's *d*, defined as the difference between group means divided by the pooled standard deviation. The pooled standard deviation was computed from the standard deviations of the two comparison groups, assuming homogeneity of variance.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee for Clinical Studies, Agartala Government Medical College, Tripura, India (Ref. No.: F.4 (6-13)/AGMC/Medical

Education/IEC Approval/2022/3993, dated 28th February 2025), following approval in the committee meeting held on 23rd December 2024. The study was conducted in accordance with the Declaration of Helsinki and the Indian Council of Medical Research guidelines. Written informed consent was obtained from all participants prior to enrolment. Participation was voluntary, and confidentiality and anonymity of data were strictly maintained.

Results

All 150 first-year MBBS students completed the study and were included in the analysis. Baseline pre-test scores across the cardiovascular system (CVS), respiratory system (RS), and central nervous system (CNS) modules were comparable among the three teaching–learning methods, with no statistically significant differences observed. Standardized effect size analysis further confirmed negligible baseline differences (small Cohen's *d* values), indicating comparable starting knowledge across groups (*Table 1*).

Table 1: Comparison of Pre-test and Post-test Scores Across Teaching–Learning Methods

Comparison	*Phase*	*Module*	*Group 1 (Mean ± SD)*	*Group 2 (Mean ± SD)*	*Mean difference*	*Cohen's d†*	*P-value*
Jigsaw SDL vs. Conventional SDL	*Pre*	*CVS*	*53.91 ± 13.57*	*51.43 ± 15.81*	*+2.48*	*0.17*	*0.64*
		RS	*56.43 ± 18.45*	*58.26 ± 21.32*	*−1.83*	*−0.09*	*0.67*
		CNS	*59.13 ± 29.43*	*57.76 ± 23.21*	*+1.37*	*0.05*	*0.65*
	Post	*CVS*	*78.47 ± 11.15*	*71.09 ± 18.77*	*+7.38*	*0.48*	*0.024**
		RS	*84.52 ± 9.16*	*75.65 ± 15.44*	*+8.87*	*0.70*	*0.002**
		CNS	*83.26 ± 26.34*	*60.00 ± 19.79*	*+23.26*	*1.00*	*<0.001**
Conventional SDL vs. Interactive lecture	*Pre*	*CVS*	*51.43 ± 15.81*	*56.44 ± 15.81*	*−5.01*	*−0.32*	*0.124*
		RS	*58.26 ± 21.32*	*58.30 ± 22.68*	*−0.04*	*−0.00*	*0.99*
		CNS	*57.76 ± 23.21*	*57.87 ± 23.21*	*−0.11*	*−0.00*	*0.87*
	Post	*CVS*	*71.09 ± 18.77*	*82.89 ± 16.18*	*−11.80*	*−0.67*	*0.002**
		RS	*75.65 ± 15.44*	*71.92 ± 16.24*	*+3.73*	*0.24*	*0.25*
		CNS	*60.00 ± 19.79*	*71.06 ± 13.87*	*−11.06*	*−0.65*	*0.002**
Jigsaw SDL vs. Interactive lecture	*Pre*	*CVS*	*53.91 ± 13.57*	*56.44 ± 15.81*	*−2.53*	*−0.17*	*0.21*
		RS	*56.43 ± 18.45*	*58.30 ± 22.68*	*−1.87*	*−0.09*	*0.67*
		CNS	*59.13 ± 29.43*	*57.87 ± 23.21*	*+1.26*	*0.05*	*0.65*
	Post	*CVS*	*78.47 ± 11.15*	*82.89 ± 16.18*	*−4.42*	*−0.32*	*0.13*
		RS	*84.52 ± 9.16*	*71.92 ± 16.24*	*+12.60*	*0.96*	*<0.001**
		CNS	*83.26 ± 26.34*	*71.06 ± 13.87*	*+12.20*	*0.58*	*0.006**

Table 1: Summarizes the pre-test and post-test scores across teaching–learning methods for the CVS, RS, and CNS modules. Post-test scores in the RS module were significantly higher in the jigsaw method of SDL group (84.52±9.16) compared to both conventional SDL (75.65±15.44; p=0.002) and interactive lectures (71.92±16.24; p<0.001), indicating superior learning outcomes with the cooperative approach. Values are expressed as mean ± standard deviation. CVS: Cardiovascular system; RS: Respiratory system; CNS: Central nervous system; SDL: Self-directed learning. *Unpaired Student's *t*-test. $p<0.05$ is considered statistically significant.

Following the teaching interventions, post-test performance differed according to the teaching–learning method employed. Students exposed to jigsaw-based self-directed learning (SDL) demonstrated superior learning outcomes compared to those undergoing conventional SDL across all three modules. The magnitude of improvement was educationally meaningful, with moderate to large standardized effect sizes, particularly in the RS and CNS modules (*Table 1*).

When conventional SDL was compared with interactive lectures, post-test performance favored interactive lectures in the CVS and CNS modules, while no meaningful difference was observed in the RS module. Effect size analysis supported these findings, indicating moderate effects where statistical significance was present (*Table 1*).

Comparison between the jigsaw method of SDL and interactive lectures revealed that the jigsaw method was associated with better post-test performance in the RS and CNS modules, with moderate to large effect sizes, whereas performance in the CVS module was comparable between the two methods (*Table 1*).

The distribution of post-test scores across different teaching–learning methods for the CVS, RS, and CNS modules is depicted in *Figure 1*, *Figure 2*, and *Figure 3*, respectively. These figures demonstrate a greater proportion of students achieving higher score categories following the jigsaw method of SDL, particularly for the RS and CNS modules.

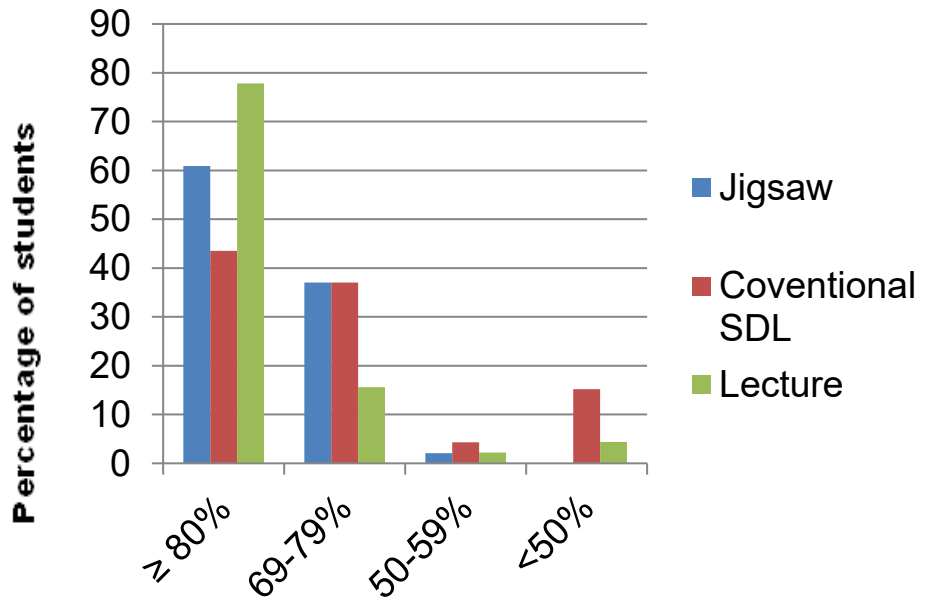

Figure 1: Distribution of post-test scores of the CVS module among the students

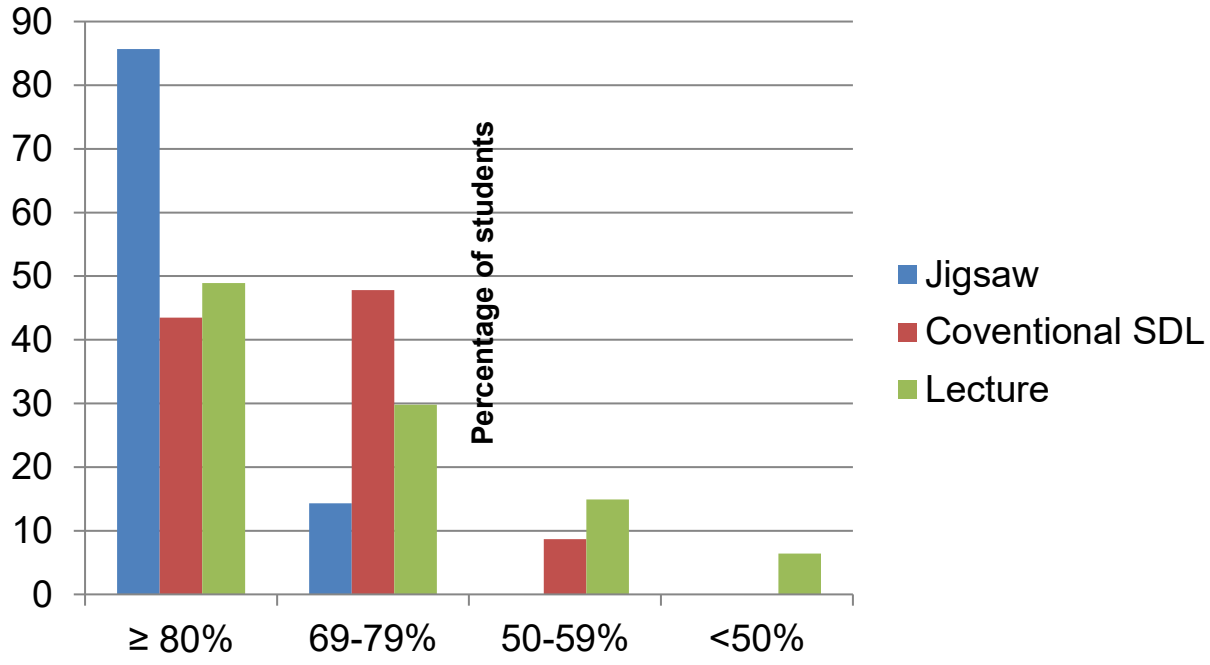

Figure 2: Distribution of post-test scores in the RS module.

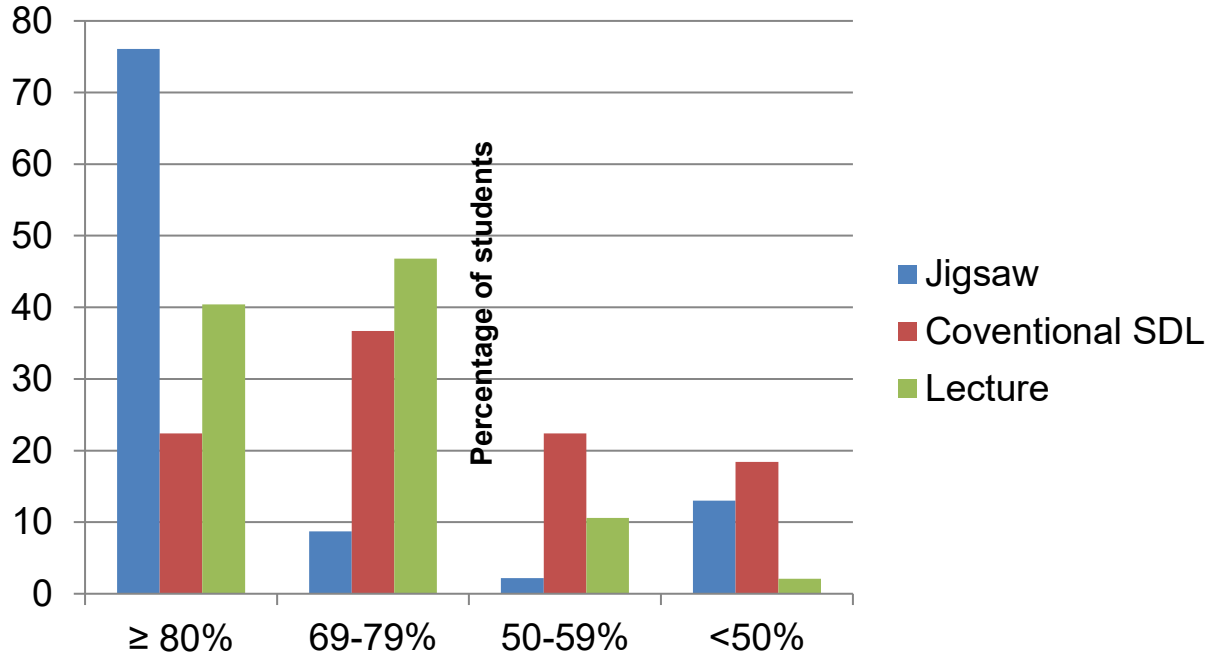

Figure 3: Distribution of post-test scores of the CNS module among the students

Discussion

Effectiveness of Self-Directed Learning in Physiology Teaching

The present study reinforces the growing evidence that learner-centered teaching–learning methods are more effective than traditional teacher-centered approaches in undergraduate medical education. Improvement in post-test scores across all three teaching–learning methods indicates that active engagement, whether through interactive lectures or self-directed learning (SDL), positively influences learning outcomes. These findings are consistent with earlier studies demonstrating the effectiveness of

SDL in enhancing understanding and active learning among medical undergraduates.[1–4] Robinson and Persky emphasized that SDL fosters learner autonomy, motivation, and responsibility, which are essential characteristics of adult learning in medical education.[5]

Superiority of the Jigsaw method of SDL over Conventional SDL

The jigsaw method of SDL demonstrated superior learning outcomes compared to conventional SDL across all modules, particularly in the respiratory and central nervous system topics. The structured cooperative framework of the jigsaw method likely accounts for this advantage, as it mandates individual accountability, peer teaching, and collaborative problem-solving. Similar findings have been reported by Singaravelu and Madhusudan, who observed significantly better academic performance with jigsaw teaching compared to small group teaching.[6] Gowda et al. also reported improved post-test scores and enhanced communication skills following jigsaw-based cooperative learning, highlighting its dual academic and skill-building benefits.[7]

Comparison of SDL with Interactive Lectures

The present study found that interactive lectures were more effective than conventional SDL for selected modules, suggesting that guided instruction and structured facilitation remain important, especially for complex physiological concepts. This observation aligns with the findings of Chaudhuri et al., who highlighted the importance of facilitation and structure in SDL sessions during the implementation of

competency-based medical education.[9] However, the jigsaw method outperformed interactive lectures in the respiratory and central nervous system modules, indicating that cooperative peer-assisted learning may provide additional cognitive advantages beyond faculty-led instruction.[8,10] Although the jigsaw method of SDL demonstrated superior outcomes in most modules, interactive lectures yielded comparatively better performance in the cardiovascular system module. This finding may be attributed to the hierarchical and integrative nature of cardiovascular physiology, which often requires structured explanation, real-time feedback, and clarification of complex regulatory mechanisms. Instructor-led sessions may therefore facilitate better conceptual scaffolding and immediate resolution of misconceptions in such content areas.

Influence of Topic Characteristics on Learning Outcomes

The variation in effectiveness of teaching–learning methods across different physiological systems suggests that topic complexity and the need for conceptual integration influence learning outcomes. Modules such as respiratory and central nervous system physiology, which require integration of multiple concepts and functional correlations, appear particularly suited to cooperative learning strategies. Peer discussion and explanation inherent to the jigsaw method may facilitate deeper understanding and long-term retention in such topics.

Implications for Competency-Based Medical Education

The findings of this study are well aligned with the principles of Competency-Based Medical Education (CBME) advocated by the National Medical Commission. The jigsaw method of SDL supports key competencies expected of the Indian Medical Graduate, including lifelong learning, teamwork, communication skills, and reflective practice. Importantly, the method is feasible, scalable, and does not require additional infrastructure, making it suitable for implementation in large undergraduate classes and resource-constrained medical colleges.

Limitations:

The allocation of students into groups based on institutional roll numbers may have introduced potential allocation bias, as randomization was not employed. Although this approach ensured administrative feasibility, future studies should consider random allocation to strengthen internal validity.

The findings of this study should be interpreted in light of its single-institution setting and context-specific implementation. Variations in faculty expertise, institutional resources, and learner characteristics may influence the effectiveness of teaching–learning methods. Therefore, caution is warranted in generalizing these results, and further multicentric studies are needed to validate the observed outcomes.

Conclusion

The Jigsaw method of SDL was much more effective compared to Conventional SDL and Lecture classes. This interactive and proactive technique can be adopted in teaching to embrace the CBME. It is also important that faculty be sensitized and trained to implement this method effectively.

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