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Assessing the impact of jigsaw technique for cooperative learning in undergraduate medical education: merits, challenges, and forward prospects

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Abstract

Background Jigsaw method is a structured cooperative-learning technique that lays the groundwork towards achieving collective competence, which forms the core of effective clinical practice. It promotes deep learning and effectively enhances team-work among students, hence creating a more inclusive environment.

Objective Present study was designed to introduce jigsaw model of cooperative learning to early-year undergraduate medical students, measure its effectiveness on their academic performance, and evaluate the perspectives of both students and faculty members regarding the same.

Methods It was a mixed method research, involving eighty second-year undergraduate medical students. The jigsaw cooperative learning approach was introduced in two themes within neurosciences module. Students were divided into two equal groups, with one group experiencing typical small-group discussions (SGDs) in first theme and other group exposed to jigsaw approach. The groups were then reversed for second theme. Following the activity, an assessment comprising multiple-choice-questions was conducted to evaluate the impact of jigsaw technique on students' academic performance, with scores from both groups compared. Student perspectives were gathered through self-designed and validated questionnaire, while faculty perceptions were obtained through focus group discussions. Quantitative data were analyzed using SPSS v22, while thematic analysis was performed for qualitative data.

Results The students of jigsaw group displayed significantly higher median assessment score percentage compared to control group ($p=0.003$). Moreover, a significantly greater number of students achieved scores ≥ 60% in jigsaw group compared to control group ($p=0.006$). The questionnaire responses indicated a favorable perception of this technique among students, in terms of acceptance, positive interdependence, improvement of interpersonal skills, and comparison with typical SGDs. This technique was also well-perceived within the educational context by faculty members.

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Conclusion The jigsaw method is associated with higher levels of academic performance among students when compared to typical small-group discussion. The students and faculty perceived this technique to be an effective cooperative learning strategy in terms of enhanced student engagement, active participation, and a sense of inclusivity.

Keywords Active-learning, Cooperative-learning, Jigsaw, Small group discussion, Undergraduate medical education

Introduction

Modern medical education emphasizes the creation of a nurturing learning environment that can transform students into knowledgeable and skilled professionals [1]. The use of effective teaching methodologies is indispensable to serve this purpose [2]. As a consequence, the field of medicine is constantly evolving, with evidence-based practices replacing the generic methodologies of the past [3]. Similarly, education in medical science is transitioning from passive, teacher-centered learning to active, team-based, student-centered learning approches [4]. This transition is essential to cope with ever-changing and complex healthcare practices, as it not only meets the didactic goals but also promotes the development of critical skills required by modern-day physicians, such as communication, leadership, and collaboration [5]. Nevertheless, there is ample room for the adoption of newer or novel approaches [6].

Present-day academicians are using a wide array of methodologies, among which the approach of cooperative learning has proven beneficial in promoting the academic performance of students [7–9]. Cooperative learning is a unique active-learning strategy involving a team of learners cooperating with each other in problem-solving and completing assignments and/or tasks to achieve the desired learning outcomes [10]. This approach primarily relies on students' efforts in active discussion of the given course material and not merely lectures and explanations by educators [11]. It allows students to be good listeners, show respect to team members, share knowledge, develop critical thinking, and take responsibility for their learning (i.e., self-directed learning), which subsequently leads to concept building, greater academic productivity, and knowledge retention [10, 11]. It is crucial to note that the attainment of these competencies is strongly linked to the enhanced development of cognitive abilities and professional identity among students [5]. The theoretical basis of this methodology lies in the idea of 'social constructivism' presented by Vygotsky, which concludes that effective learning occurs as a result of social interaction among different individuals [12].

Collective competence forms the core of effective clinical practice, as most clinical conditions require the services of multidisciplinary teams for appropriate patient management [13, 14]. The majority of healthcare professionals are proficient individually, however, they lack the ability to work cohesively as a team. This may negatively impact patient care, leading to substandard provision of healthcare [15, 16]. Deficiency in collective competence among doctors can partly be attributed to limited application of cooperative learning methodologies in the early years of the medical curriculum [17, 18]. Thus, there is a growing need for reviewing and enhancing educational approaches to achieve collective competence. For this reason, medical schools across the globe are advised to prioritize the development of interpersonal, communication, and teamwork skills among the students right from the outset of their educational programs [19].

The medical school where this study took place currently employs facilitator-guided small group (12–13 students) discussion format as a student-centered cooperative learning approach. Challenges may arise during these sessions as the early-year undergraduate medical students are not accustomed to this cooperative active learning strategy [20]. These pervasive challenges include unequal involvement of students, poor communication leading to misunderstandings, disagreements over ideas and approaches, and convoluted group dynamics characterized by individuals who may be reserved, overly vocal, or domineering. Moreover, simply placing students in small groups is not enough to guarantee beneficial cooperative learning [5]. Similar challenges have also been reported across a range of different small group learning activities designed to promote cooperative learning, including problem-based learning, team-based learning, group assessments, and collaborative projects. These challenges can be attributed to students' inexperience with group work, unclear objectives, and a lack of collaborative skills [19]. Thus, there is a vital need for utilization of structured and guided cooperative learning approaches, and the jigsaw model of cooperative learning appears to be an appealing solution in this regard.

Jigsaw method is one of the structured cooperative learning techniques. In this approach, participants are divided into groups. Each group is given a set of learning objectives to prepare and master together through active discussion [21]. Afterward, participants are arranged into new groups, with each having one member from the original groups [21]. Subsequently, members of new group teach each other the topics they prepared by actively participating and engaging with each other [21, 22]. Notably, the jigsaw cooperative learning approach operates efficiently with minimal facilitators [23], the primary

role of the facilitator is to monitor student preparation, ensuring consistency in topic preparation, and maintain the smooth flow of discussions [24]. Effective time management is crucial in this method, considering it may require more time to cover a particular topic compared to traditional lectures [25]. Beyond its logistical aspects, this approach has the potential to enhance cooperation among participants and promote inclusivity and diversity by mitigating preconceived societal biases related to gender, ethnicity, and other factors [26, 27]. Jigsaw method being active and learner-centered, aligns with objectives of modern medical education and lays the groundwork towards achieving collective competence [28]. Despite of its multiple advantages, jigsaw technique is not widely adopted by various medical schools. This can be attributed to limited awareness of educators regarding this technique and its potential to enhance collaboration and achievement of learning outcomes [1].

Jigsaw technique inspires cooperation among students, refines communication skills, and helps in better understanding of knowledge [29]. There is a notable amount of evidence available in the literature regarding the effectiveness of the jigsaw technique in the later years of undergraduate [24, 30, 31] as well as postgraduate [23] medical education. However, there is a lack of comprehensive information regarding the educational impact of jigsaw cooperative learning and the perspectives of students and faculty members directly involved in the jigsaw cooperative sessions in the early years of medical education. This gap in the literature necessitates conducting detailed studies to comprehensively explore the effectiveness of this approach. Present study was designed to introduce jigsaw model of cooperative learning, measure its effectiveness on students' academic performance, and evaluate the perceptions of both students and faculty members regarding the jigsaw technique among second-year undergraduate medical students. To the best of our knowledge, this study is the first to compare the effectiveness of jigsaw technique with small group discussions on academic performance of the early-year undergraduate medical students.

Materials and methods

Settings

This study was conducted at Shifa College of Medicine, a constituent college of Shifa Tameer-e-Millat University, Islamabad, Pakistan. The strategy was implemented in Neurosciences (NEU) module of second-year MBBS class. A total of two jigsaw cooperative learning sessions of two hours each were conducted during the month of August 2022. Jigsaw technique was introduced for two topics from the theme of sensory neurophysiology, i.e., *"Tactile, position, and vibration sensations"* and *"Pain and temperature sensations".*

Participants

There were a total of one-hundred students in second-year MBBS class. Only those students were included in the study who participated in jigsaw cooperative learning sessions and took the subsequent assessment. The students who were absent were excluded from study sample. Thus, a total of eighty students participated in the study (response rate was 100%).

In addition, the study also involved ten faculty members. Those faculty members who were involved in planning and observing the jigsaw cooperative learning sessions were included in the study.

Study design

This study utilized explanatory mixed-method research design, incorporating both quantitative and qualitative methods. The quantitative component of the study employed a quasi-experimental design to assess the effectiveness of the jigsaw technique through assessment. Views from students were gathered using a self-designed validated questionnaire comprising both quantitative (likert-scale type) and quantitative (open-ended) questions. Additional qualitative methods involved evaluations of faculty members' perspectives obtained via focus group sessions.

Study groups

Initially, there was a large group interactive session on the topic of tactile, position, and vibration sensations. Following this, the study participants ($N=80$) were divided into two equal groups: the control and jigsaw experimental groups. These groups were carefully curated to ensure equitable distribution of students, taking into account factors such as gender, ethnic background, and prior academic performance. The control group discussed this topic in the regular small group discussion session, a modality already established in the institute where the study took place. Meanwhile, jigsaw technique was employed for the experimental group of study participants. The control and experimental groups were reversed for the topic of pain and temperature sensation to provide balanced comparison and better evaluate the effectiveness of this technique. The sessions for the second topic were also preceded by an overview large group interactive session.

Typical small group discussion sessions

For typical small group discussion session, the students were given learning objectives and resources for the specific topic three days prior to the small group session. They then independently studied those topics. Following this, students participated in small group discussion. There were twelve-thirteen students in each small group that was guided by a facilitator. The facilitators were

faculty members who ensured effective management and active participation of each student in the group [25].

Jigsaw cooperative learning sessions

For the jigsaw cooperative learning sessions, a structured approach was employed to enhance collaboration among the students. There were two phases to it: the preparation phase and the jigsaw discussion phase. In the first phase, the experimental group was divided into seven expert teams labelled as A, B, C, etc. The grouping was done while keeping diversity into consideration in terms of gender, ethnicity, and academic performance of the students. Each expert team comprised six to seven diverse students, who were allotted 2–3 learning objectives. Students were given 60 min to work together and compare their ideas and insights to improve their comprehension and collectively attain competence in the assigned topics. To facilitate coordination and ensure subsequent participation in next phase, each student within the expert team was assigned a unique color.

After the preparation phase, students transitioned to their jigsaw discussion teams in accordance with the assigned color. One student from each expert team was part of subsequent jigsaw discussion team. This arrangement ensured that each jigsaw discussion team comprised members who were experts in different aspects of the topic (i.e., different learning objectives) to promote dynamic exchange of knowledge. Subsequently, in the jigsaw discussion phase, the students presented and explained their respective topics to their jigsaw discussion team peers, who actively listened and asked questions. This interactive session was designed to create a constructive learning environment that can promote deeper engagement, effective communication, excellent teamwork skills, critical-thinking, and comprehensive understanding of the given material. Time designated for this activity was 60 min.

This entire process was supervised by four faculty members, who provided guidance and facilitated the students as needed. This activity was conducted in lecture hall to enable effective oversight and support as the faculty members easily moved from one group to another. Furthermore, two faculty members were tasked with overseeing the overall design, observation, and troubleshooting of the jigsaw activity. After this session, students evaluated the performance of their peers, based on their contributions to the discussion. They were encouraged to recognize and commend outstanding team members to promote a culture of motivation and appreciation within the group.

Same activity was conducted the next day for the topic of "Pain and temperature sensations". In that, the control and experimental groups were reversed. Students who had been in the control group at first were placed in the experimental group, and students in the experimental group were placed in the control group. Same structured strategy was implemented.

Figure 1 shows the steps of methodology which were followed in the present study.

Evaluation of students' performance

At the end of activity on both days, there was an assessment of all the students. This included multiple-choice questions (MCQs) categorized at cognitive levels 2 and 3 of Bloom's taxonomy. These questions were carefully reviewed and approved by subject specialists to ensure their relevance and accuracy. Students provided the answers on optical mark recognition (OMR) sheets. Results of this assessment were acquired from examination department of Shifa College of Medicine. Feedback was provided to the students after assessment. The scores were compared between the control and jigsaw experimental groups.

Evaluation of students' perceptions

Perceptions of the students regarding jigsaw cooperative learning were gathered by administering a questionnaire after taking informed consent, and survey responses were kept anonymous. The questionnaire was administered on the day of the activity, after the conclusion of jigsaw session. Questionnaire was designed after thorough literature review. It had two sections. Section I (quantitative) had 13 likert-scale type questions to measure the perceptions of students. Scale of 1–5 was used, with scoring 1=highly disagree, 2=disagree, 3=neutral, 4=agree, and 5=highly agree). Section II (qualitative) contained three open-ended questions addressing positive aspects, negative aspects, and comments regarding the jigsaw cooperative learning sessions. The questionnaire evaluated various features of jigsaw cooperative learning, such as acceptance, interpersonal skills, positive interdependence, and comparison with typical small group discussion sessions. The questionnaire was validated by four experts and piloted with 15 students to ensure clarity and comprehension. The internal consistency of all questionnaire items, as checked using Cronbach's alpha, was 0.95. The Cronbach's alpha values for the scales of acceptance, positive interdependence, personal and interpersonal skills, and comparison with small group discussion format were 0.89, 0.81, 0.85, and 0.92, respectively.

Evaluation of faculty's perceptions

For the evaluation of perceptions of the faculty members regarding Jigsaw cooperative learning sessions, data were collected through focus group discussion session after taking informed consent. During focus group sessions, participants shared their responses to a predesigned set of questions, following informed consent. Two focus

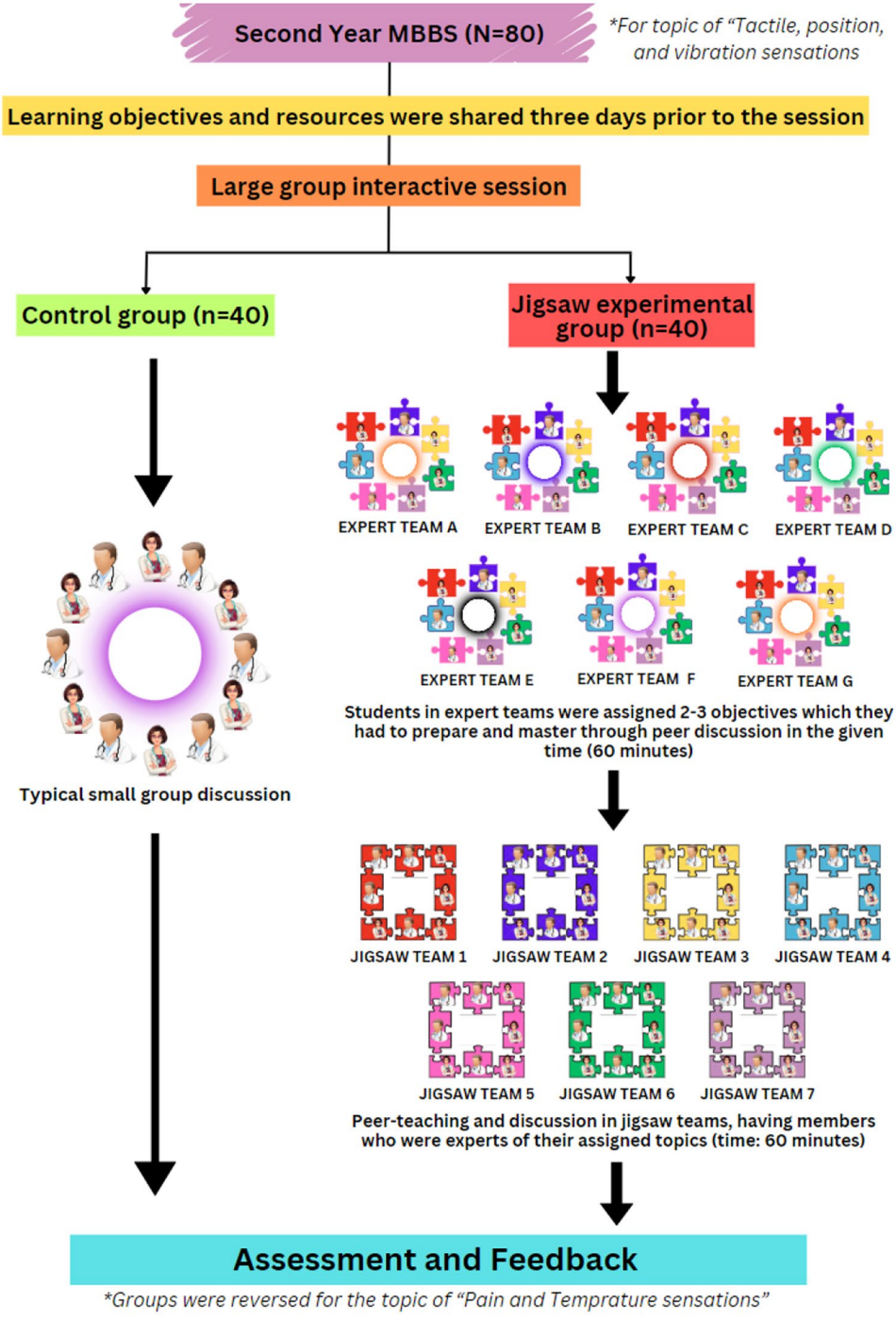

Fig. 1 Steps of methodology employed for control and jigsaw experimental groups in a cohort of second-year undergraduate medical students

group sessions were conducted with five faculty members in each focus group, including four facilitators and one observer. The questions for focus group were developed after thorough literature review. The questions explored the faculty's views regarding their experience of planning and conducting jigsaw cooperative learning sessions and its impact on student academic performance.

Analysis

Data obtained were analyzed on IBM's statistical package for social sciences (SPSS) version 22. Descriptive statistics were used for the quantitative data in survey questionnaire. For qualitative data, themes and sub-themes were identified for analysis. Normality of the data was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. The scores of assessment were expressed as median

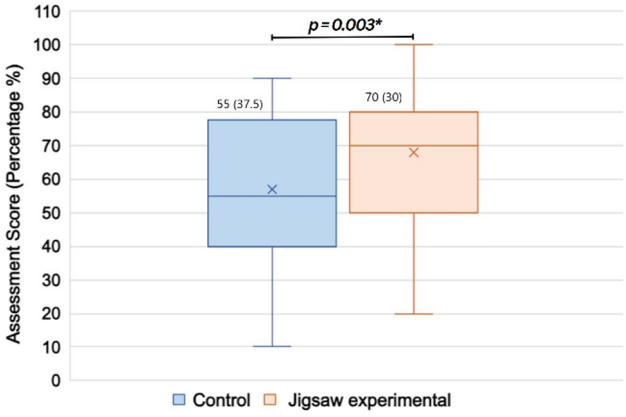

Fig. 2 Median and interquartile range of assessment scores in control and jigsaw experimental groups

Table 1 Frequency of students scoring 60% or higher in control vs. jigsaw experimental groups (Mann-Whitney U test)

Groups	Frequency (Percentage) of students with ≥ 60% score *N* (%)	*p*-value
Control group	40 (50%)	**0.006***
Jigsaw experimental group	51 (71.3%)	

**p*-value of < 0.05 is considered significant

and interquartile range. Comparison between control and jigsaw experimental groups was done by employing Mann-Whitney U test. A *p*-value of < 0.05 was considered significant.

Results

Quantitative findings

Assessment scores

To check the effectiveness of jigsaw method of cooperative learning, an assessment was conducted. Since the sample size was small, the distribution of data (assessment score percentage) was assessed by employing Kolmogorov-Smirnov test and Shapiro-Wilk test. The analysis showed that data was not normally distributed in control group (Kolmogorov-Smirnov *p*-value = 0.003, Shapiro-Wilk *p*-value = 0.005) and experimental group (Kolmogorov-Smirnov *p*-value = 0.002, Shapiro-Wilk *p*-value = 0.004). Based on this outcome, median and interquartile range were used to summarize the assessment score percentages (Fig. 2). The comparison between the two groups was done using non-parametric Mann-Whitney U test. The results of this test were statistically significant. The results imply that jigsaw model of collaborative learning contributes to higher levels of academic performance among students.

Table 1 represents the frequency (percentage) of students who scored 60 or more than 60% marks in assessment in control and jigsaw experimental group. Comparison between the groups was done using Mann-Whitney U test. A higher percentage of students scored 60 or more than 60% marks in jigsaw experimental group as compared to control group. The difference was statistically significant, indicating the efficacy of this method in enhancing the academic performance of students.

Students' perceptions

The perceptions of students were gathered by administering a questionnaire. There were a total of 80 respondents. Amongst them 41 (51.25%) participants were females and 39 (48.75%) participants were males. Mean age of participants was 20.46 ± 0.795 years.

The results imply that students perceived this technique favorably in terms of acceptance, promotion of positive interdependence, development of interpersonal skills, and comparison with typical small group discussion format. The results of quantitative data are shown in Fig. 3(A-D).

Qualitative findings

Students' perceptions

The perceptions of students regarding jigsaw technique were also explored through qualitative questions. Answers of the respondents were coded and thematic analysis was done.

- **Positive aspects of activity**

  Students were asked about the positive aspects of activity that they experienced during this whole process. Students identified different aspects of learning processes which they thought were improved by employing jigsaw method of cooperative learning (Fig. 4A).

1. ***Better comprehension of concepts***: According to most of the respondents this activity helped them understand the different topics in a better manner. They opined that this activity facilitated in clearing the concepts about the topics through discussion and debate. The students felt that after this activity they had a stronger grip on the subject. The students responded; *"This activity gave me clarity about the concepts of the given topics"* and *"Through this activity I got an opportunity to have an in-depth understanding of the topic".*

2. ***Well-organized learning***: Most of the participants shared that this activity helped them learn the different aspects of the topic in a structured manner. The process was smooth as a list of clear learning objectives was given to students which they had to present and discuss in a sequential manner.

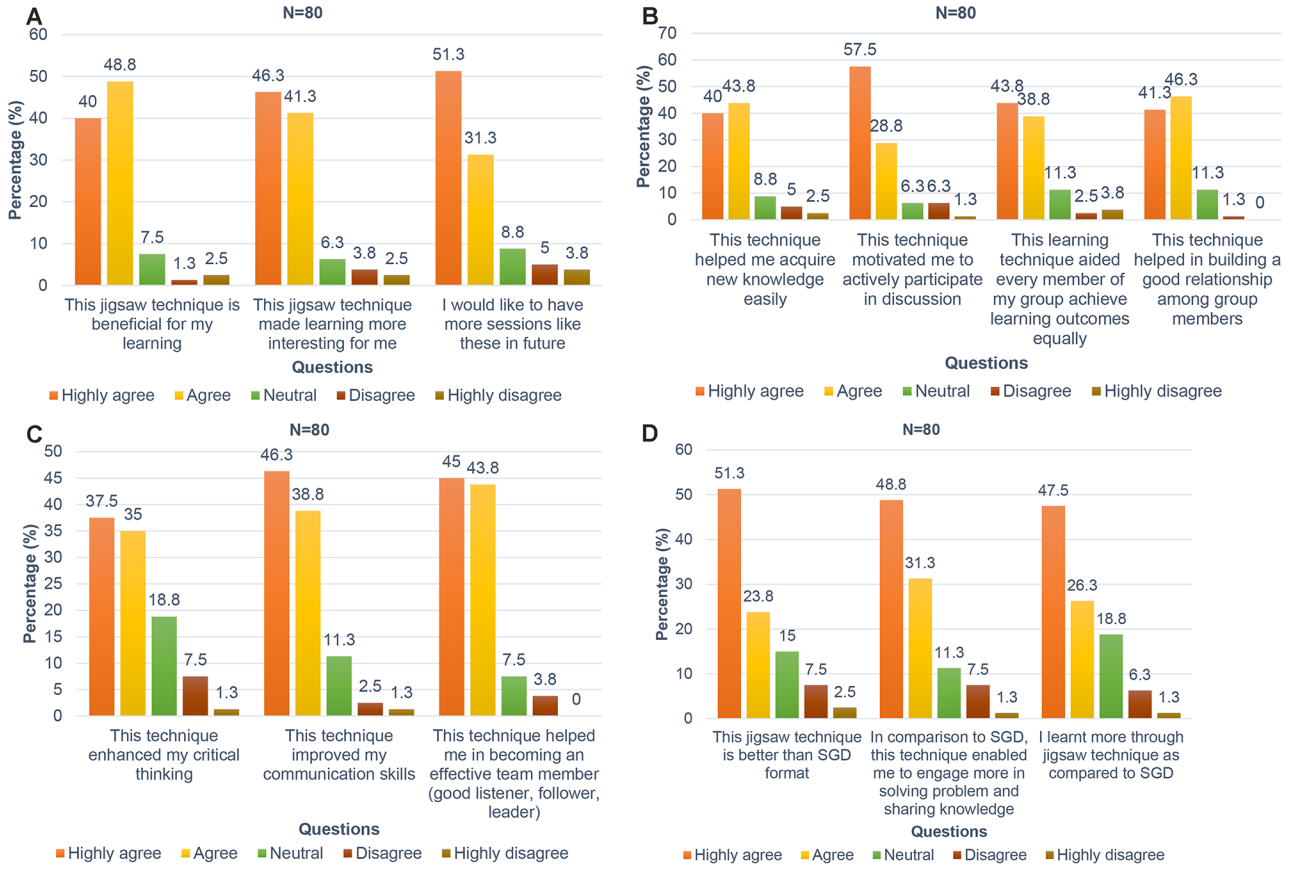

Fig. 3 (**A**) Results of questions regarding students' acceptance of Jigsaw technique. (**B**) Results of questions showing students' perceptions regarding positive interdependence of Jigsaw technique. (**C**) Results of questions showing students' perceptions regarding benefits of Jigsaw technique in improving personal and interpersonal skills. (**D**) Results of questions showing students' perceptions regarding comparison of Jigsaw technique with Small group discussion (SGD)

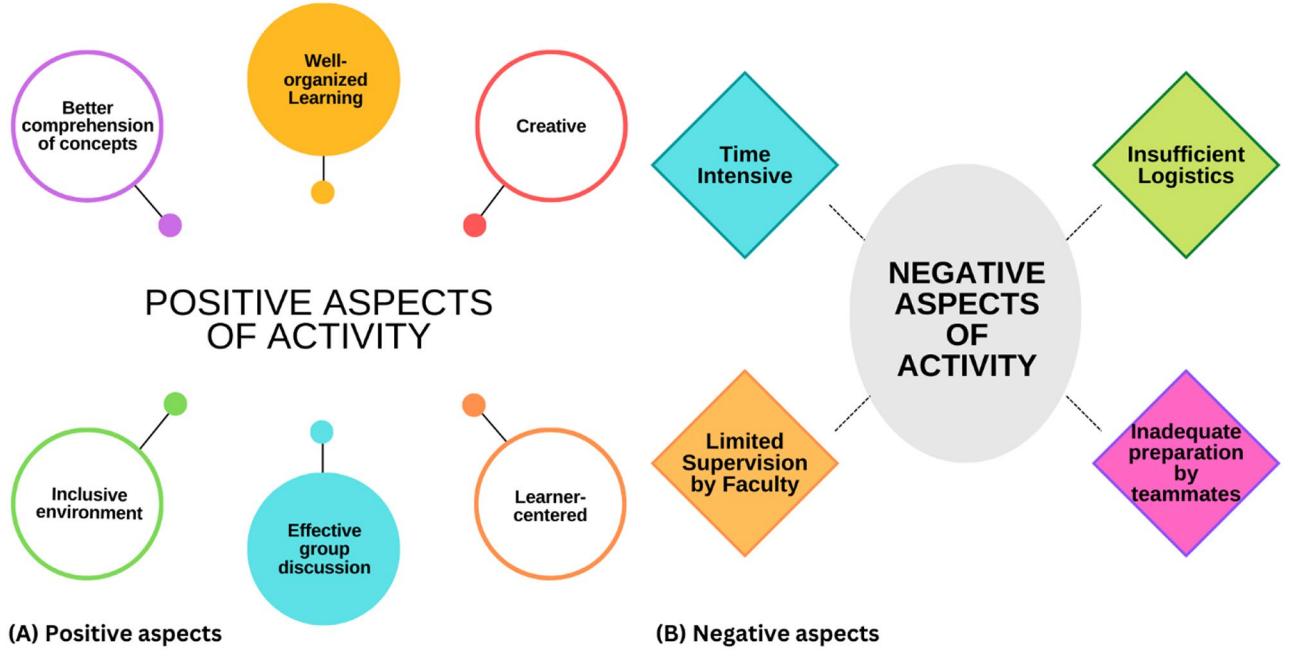

Fig. 4 Positive and negative aspects of Jigsaw technique identified by students

Participants appreciated that there were less number of students per group which promoted learning without interruption. One of the participants said, *"Less members, less problems! This technique aided in better one-to-one communication with group members"*. Students also appreciated the assessment and feedback at the end of this activity which further aided them to master the topics.

3. ***Creative***: According to the respondents this jigsaw method of cooperative learning encouraged creativity that made the learning process more interesting. It allowed the learners to gain an in-depth understanding of the topic and then elaborate and explain those topics to their peers. This process boosted their motivation to learn and engagement in the activity. It allowed them to integrate the diverse perspectives of their teammates regarding the given topics, which subsequently led to better understanding and higher intellectual output.

4. ***Inclusive environment***: The participants described that this learning strategy stimulated them to actively participate in discussion. This process gave every member of the group an opportunity to speak and contribute to the learning process. As each student in jigsaw group had to present their assigned topic that aided them in taking a more active role during the discussion. This aspect is particularly beneficial for introverted students as it could give them autonomy and boost their self-esteem. Some of the participants responded; *"The best part about this activity is that everyone contributes to the discussion"* and *"I liked that I contributed to the discussion without feeling of being spoken over by others constantly".*

5. ***Effective group discussion***: According to the participants, discussion through jigsaw technique was fruitful as it urged every member to actively listen, effectively speak, and share thoughts and ideas with their teammates. The discussions were highly interactive and constructive for learning. As there were less members per group, it was easy for the students to communicate with their team members. Everyone had time for thorough preparation and presentation of their topic. A few participants labeled the discussion to be '*productive*' as the students felt motivated to stay attentive, think profoundly, describe the topics with reasoning, and listen with purpose. One of the participant responded; *"This method is highly interactive, each member was focused and explained the topics efficiently".*

6. ***Learner-centered***: Some respondents described that this whole process gave them the liberty to take responsibility for their learning. Many students appreciated the active engagement of all the teammates, collaboration among members, and tutor-absent independent learning. Participants responded; *"The positive point about this activity is that it provided the opportunity to learn independently without direct supervision by teachers"* and *"Every member had a chance to participate, it is easier to understand in small groups without everyone trying to impress faculty".*

- **Negative aspects of activity**

Students were asked about the negative aspects of activity that they experienced during this whole process. Students pointed out a few weaknesses which hindered the effectiveness of cooperative learning (Fig. 4B).

1. ***Time intensive***: According to most of the participants, this activity took a lot of time for its completion. This became exhausting for them after some time. One of the student explained; *"The activity was too long and draining, I wasn't able to pay attention at the end"* and *"It took so much time that by the end I felt saturated".*

2. ***Insufficient logistics***: The participants pointed out a few shortcomings in terms of non-availability of required logistic support. The students identified;

   - More groups in one lecture hall made it difficult for them to discuss as there was a lot of background noise.
   - Switching from expert teams to jigsaw teams created a lot of disturbance and confusion in that limited space.

3. ***Limited supervision by faculty***: As this activity was student-centric, the respondents described that input from faculty was not adequate. Students were apprehensive that they might perceive the concepts wrongly. They were concerned that they had less interaction and guidance from faculty members that could result in poor academic attainments.

4. ***Inadequate preparation by teammates***: Most of the students were of the opinion that a few topics were not explained satisfactorily by their teammates. They shared that they would have understood the

concepts better if they had prepared those topics by themselves. Some participants responded; *"Some members didn't explain their part well, I had confusion in those topics"* and *"I feel like some topics explained by others could have been better, I must have understood it better, if I read it up myself".*

Faculty members' perceptions

The perceptions of faculty regarding jigsaw technique were also explored through qualitative questions in a focus group session. Answers of the respondents were coded and thematic analysis was done.

1. ***Benefits for students***: In focus groups session the faculty members identified the following beneficial aspects of the jigsaw activity;

   - Students have plenty of time while discussing in expert groups to clarify their misconceptions and queries regarding the given topics. So, by the end of round one, most of the students of expert group are at the same level of knowledge.
   - Students get a chance to discuss every topic in detail and no learning objective is skipped during discussion.
   - This activity is innovative, that is why it grasped students' attention and if practiced more often, it can lose its essence.
   - It is a type of modified directed self-learning, in which students are given a direction in the form of learning objectives and then students work together on it towards a common educational goal.
   - As this activity is supervised, students are bound to participate. Otherwise, in self-directed learning sessions, most of the students do not study as there is no check on them by the faculty.

2. ***Benefits for faculty***: According to faculty members, they see following benefits of this jigsaw technique for themselves;

   - During this activity a teacher has more passive role due to which there is less workload on teachers while the activity is being conducted.
   - The faculty can observe and supervise more number of students at a time.
   - Whilst the students discuss, a teacher observing them can identify the educational and social strengths and weaknesses of students.

3. ***Logistics and time for activity***: The faculty members responded that the jigsaw collaborative learning activity was managed well, however, it could have been more organized if the groups sit in large spaces to avoid background noise. Regarding the time, one of the teacher said, *"Time was enough for this topic, most of the students grasped the topics really well".* The rest of the focus group members agreed to it.

4. ***Disadvantages of activity***: Respondents opined that;

   - As the students were discussing the learning objectives one-by-one in a logical sequence in jigsaw discussion groups, a few students were focused on revising the topic that they had to teach their peers. Their attention was diverted towards the topics they had to present rather than listening to their peers, which might have slowed down their learning.
   - Students were segregated on the basis of diversity so the level of knowledge and pace of learning of every student was different, due to which a few slow paced-learners were struggling with their topics.
   - It requires a lot of pre-session effort and time of faculty to design such activity.

5. ***Comparison with other techniques***: In comparison to other cooperative learning strategies such as problem-based group learning and typical small-group discussion session the teachers advocated that jigsaw technique was more fruitful in terms of;

   - Clarity of learning objectives, as they were designed by subject specialist as compared to problem-based learning sessions, in which the students formulate the learning objectives.
   - Unnecessary details are avoided during jigsaw discussion as it is more focused and each students is aware of his/her topic and role as a group member.
   - It is more interesting and engaging for students.

Perceptions of faculty recorded in focus group are summarized in Fig. 5.

Discussion

In the present study, the implementation of the jigsaw cooperative learning strategy was associated with higher levels of academic performance among second-year undergraduate medical students. Additionally, both students and faculty perceived this technique as an effective approach to cooperative learning. There is a scarcity of

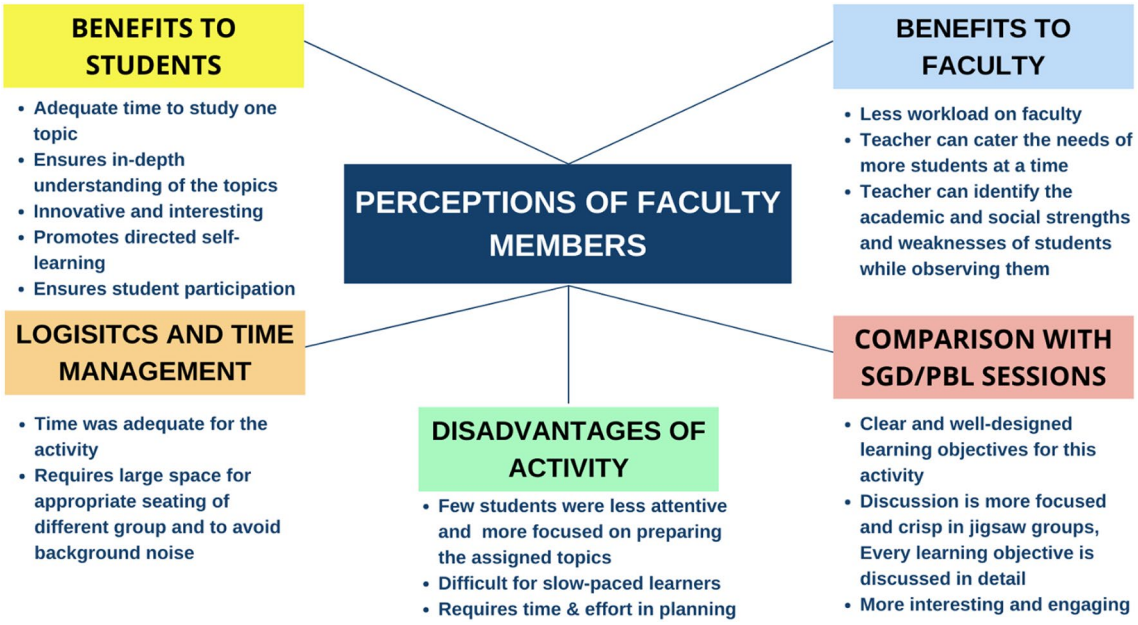

Fig. 5 Perceptions of faculty regarding Jigsaw technique (Results of focus group discussion)

research examining the effectiveness of the jigsaw technique as an instructional method for early-year undergraduate medical students, particularly in comparison with other active learning strategies. To the best of our knowledge, the present study is the first to compare the effectiveness of the jigsaw technique with small group discussions on the academic performance of early-year undergraduate medical students.

The quantitative findings of this study demonstrate that the jigsaw model of cooperative learning had a positive impact on the academic performance of second-year undergraduate medical students. Several other studies have also investigated the efficacy of this educational tool on students' academic achievement. It is worth highlighting that in majority of these investigations, jigsaw method has been juxtaposed against conventional teaching approaches. Jafariyan et al. compared this technique with lecture-based teaching in a physics course for clinical laboratory and public health students, reporting significantly higher mean posttest scores in the jigsaw group [32]. Phillips et al. introduced the jigsaw technique to teach clinical controversy in a clinical skills course offered to pharmacy students, with individual quiz results suggesting the technique's effectiveness in teaching the concepts [30]. Kumar et al. assessed the effectiveness of the jigsaw technique compared to tutorials in enhancing cognitive skills among medical students in microbiology, reporting higher mean post-test and retention test scores in the jigsaw groups [24]. Goolsarran et al. compared the effectiveness of the jigsaw method with traditional small group learning to teach principles of diagnostic reasoning to postgraduate internal medicine residents, noting statistically significant improvements in post-test and one-year follow-up test scores with the jigsaw method [23].

The results of the present study suggest that students perceived the jigsaw technique positively. They believed that the technique not only enhanced their learning and comprehension, but also made the entire learning experience interesting and enjoyable. Kumar et al., Bhandari et al., and Jafariyan et al., also reported that students found jigsaw-based learning to be more profound, effective, and enjoyable [24, 29, 32]. Furthermore, students in the present study expressed that the jigsaw technique motivated them to actively participate in discussions and helped promote inclusivity and positive interdependence. They perceived that the technique facilitated the establishment of good relationships among group members, enhanced critical thinking and communication skills, and improved personal and interpersonal skills. In a study conducted by Jeppu et al., students reported that jigsaw cooperative learning helped them stay committed, encouraged the exchange of ideas and knowledge, and led to the development of mutual trust and interdependency [5]. Lalit et al. reported that students perceived the jigsaw technique as a refreshing active learning methodology that encouraged active student participation and discussions, thereby improving their problem-solving and communication skills [25]. In a study conducted by Pahwa et al., students seemed to enjoy learning through the jigsaw method as it promoted teamwork and critical thinking [31]. The use of the jigsaw technique fosters a learning environment that encourages student engagement, empowering them to serve as both learners and teachers simultaneously

[23]. A small percentage of students (7–8%) did not perceive this technique favorably. This can be attributed to its first-time use and the demanding nature of the strategy in terms of the effort required from the students. Additionally, such active learning strategies mandate a greater degree of responsibility on the students' part [33, 34]. Some students (7–8%) did not favor cooperative nature of the technique or the idea of supporting each other's learning. Similar findings have been reported by White et al. in their study, where most students preferred individual learning and were distracted by group study, attributing this to a lack of developmental readiness for cooperative learning [34].

The qualitative findings of the present study revealed several shortcomings pointed out by students that hindered the effectiveness of the cooperative learning strategy. According to most students, the activity was time-intensive and exhausting, a finding echoed by Pahwa et al., who reported similar results [31]. This concern can be addressed by incorporating short breaks between different phases of the activity. Another apprehension shared by students was the perceived inadequacy of input from faculty, potentially leading to misconceptions about concepts. Similar concerns from students have been reported by other authors as well [25, 30, 32]. Additionally, students expressed dissatisfaction with the preparation and explanation of certain topics by their teammates. These concerns can be resolved if teachers provide a comprehensive reference outlining the learning objectives of the jigsaw technique, enabling students to confirm the accuracy and adequacy of the information. Students can also contact their teachers to resolve any misconceptions [32].

In the focus group findings, the faculty viewed the jigsaw technique favorably. They believed that the technique ensured an in-depth understanding of concepts in an interesting manner. Lalit et al. also collected faculty perceptions of the jigsaw technique and reported that faculty perceived it as a valuable learning approach that helped students become effective learners and enhance their concentration [25]. Faculty also identified several weaknesses, including some students being less attentive, slow-paced learners finding the activity challenging, and the need for time and effort in planning. This concern can be addressed by identifying and motivating passive students early on, involving them regularly in such activities, and encouraging them to realize their responsibilities. This helps transition passive learners into active participants, improving their communication skills necessary for teaching each other about assigned topics. Additionally, assigning a group member the task of teaching a subtopic to other group members can enhance personal and public accountability [5, 24]. For optimal effectiveness, the authors recommend introducing a gap between expert team discussions and jigsaw group sessions. This can give students ample time to address any disparities in understanding and build stronger conceptual foundations.

The present study demonstrates that the jigsaw technique is a feasible and effective instructional method that not only enhances knowledge acquisition but also fosters an inclusive learning environment, engages students in an interdependent manner, and emphasizes the importance of peer teaching and group work. By incorporating this technique into the undergraduate curriculum, medical educators can contribute to creating inclusive classroom spaces where students with different educational backgrounds and diverse perspectives feel a greater sense of belonging. Moreover, implementing this technique equips students with collaborative skills essential for dealing with real-world scenarios in healthcare, where interdisciplinary teamwork is crucial for providing holistic patient care.

There were a few limitations to this study. Firstly, the technique was utilized for only two topics in Physiology, and that too within a single medical college. Further experimentation is needed with different topics of varying complexity across multiple institutions. Secondly, this study did not investigate how the jigsaw technique affects students' long-term knowledge retention. Thus, future research exploring this area would contribute to a comprehensive assessment of the effectiveness of this strategy. The authors recommend integrating cooperative and team-based learning strategies from the early stages of medical education, thereby empowering future healthcare professionals to deliver effective healthcare.

Conclusion

The study concluded that the jigsaw method is associated with higher levels of academic performance among second-year undergraduate medical students when compared to typical small-group discussions. Furthermore, the students reported this technique to be an effective cooperative learning strategy that promotes in-class student engagement, active participation, and a sense of inclusivity. The faculty also found the activity beneficial in terms of promoting active learning.

Supplementary Information

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Supplementary Material 1

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Author contributions

HM Conception, data acquisition, analysis, manuscript drafting, critical revision, final approval; SM Data acquisition, manuscript drafting, critical revision, final approval; TZ Data acquisition, critical revision, final approval; SZ

analysis, manuscript drafting, final approval; AN analysis, final approval; SiM Critical revision, final approval.

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Data availability
Available upon reasonable request from corresponding author.

Declarations

Ethical approval and consent to participate
The ethical approval to carry out this study was obtained from Institutional review board and ethics committee (IRB & EC) of Shifa International Hospitals, Shifa Tameer-e-Millat University Islamabad, Pakistan (Ref: IRB#0206 – 22). Informed consent was acquired from all the study participants prior to data collection. Additionally, permission to conduct jigsaw cooperative learning sessions was obtained from module director.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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