

Comparing Knowledge Gain and Retention Among Dental Students in a Public Sector University: Jigsaw Versus Traditional Lecture: A Mixed-Method Study

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Abstract

Background

Traditional lecture-based teaching may provide limited opportunities for active and collaborative learning. The Jigsaw method promotes cooperative learning, but evidence of its effectiveness in dental education in Pakistan is limited. This study compared knowledge acquisition and retention following Jigsaw and traditional lecture-based teaching and explored students' perceptions of Jigsaw.

Methods

The study employed mixed-method research design among the third-year dental students at Dow Dental College, Dow University of Health Sciences, Karachi. Fifty students were randomly divided into Jigsaw and traditional lecture groups (25 students in each group). The pre-test and immediate post-test were completed by thirty-two students (16 per group). Three observations were removed as outliers, and the final quantitative analysis included 29 students. Retention was assessed after 4 weeks by 34 students (17 students in each group). Knowledge was assessed by multiple choice tests before, immediately after and four weeks after the teaching session. A focus group discussion was conducted to understand students' experiences of Jigsaw learning. Qualitative data were analysed thematically.

Results

Baseline scores were comparable between Jigsaw and traditional groups (7.45 ± 3.32 vs. 7.52 ± 3.25 ; $p = 0.935$). Scores improved significantly in both groups following teaching (Jigsaw: 7.45 ± 3.32 to 13.79 ± 1.24 ; traditional: 7.52 ± 3.25 to 13.31 ± 1.51 ; both $p < 0.001$), with no significant difference between groups ($p = 0.260$). Delayed retention scores were also computed (10.88 ± 2.93 vs. 10.53 ± 2.84 ; $p = 0.616$). Students reported positive experiences with Jigsaw, particularly regarding engagement, understanding, communication, teamwork, and motivation.

Conclusions

Jigsaw and traditional lectures produced comparable knowledge gain and retention. But students found Jigsaw as an interesting method which facilitated collaborative learning and professional skills. The use of jigsaw could be used along with the conventional teaching in dental education.

Background

Traditional lectures have a well-established role in health professions education, as they enable educators to efficiently deliver large amounts of information to students, but traditional lectures tend to be teacher-centered, which may reduce opportunities for students to engage in discussion, explanation,

problem-solving, and share responsibility for learning [1, 2]. Active and cooperative learning approaches attempt to fill this gap by giving opportunities for deeper processing and long-term retention, active discussion, and explanation, and problem-solving [3–6].

In health professions education, studies have reported several potential benefits of the Jigsaw teaching technique, including improved academic achievement, student engagement, communication, and knowledge retention. However, its implementation can also present challenges, particularly in terms of preparation, time, group management, and classroom organization [7–15].

However, important gaps remain in the evidence. Previous research has examined the effectiveness of the Jigsaw method compared to lecture-based education [10] and tutorial-based small group teaching [11] respectively, but there is little evidence available from public sector dental education in Pakistan. It is unclear whether the students' immediate knowledge gain and retention are better in Jigsaw than in traditional lectures. Moreover, quantitative measures alone may not fully capture students' experiences with Jigsaw, including their perceptions of its benefits and challenges, level of participation, and views on its feasibility in the classroom. Exploring these qualitative aspects alongside learning outcomes can provide a more complete understanding of the value and practical applicability of the Jigsaw approach.

The present mixed methods study therefore compares the knowledge score of the pre-test, immediate post-test and delayed post-test retention score of the students of third year BDS of public sector institution of dental college with Jigsaw & traditional lecture-based teaching method. Focus group discussions will additionally explore students' perceptions and experiences of Jigsaw. By integrating objective learning outcomes with students' perspectives, the study will provide context-specific evidence on both the effectiveness and educational feasibility of Jigsaw for undergraduate dental education.

Methods

Study design

This study employed a sequential explanatory mixed-methods design, comprising a quantitative randomized controlled trial followed by a qualitative component. The quantitative strand analyzed the effectiveness of a Jigsaw cooperative learning strategy in comparison with the traditional lecture method through immediate knowledge and delayed knowledge retention instruments. The qualitative strand focused on the experiences of students and their perceptions of the Jigsaw method, such as its perceived benefits and challenges, student engagement with the method, and the perceived feasibility of the method.

The quantitative and qualitative parts were analyzed separately, and the results were later consolidated when interpreting the findings. This approach enabled the qualitative findings to provide contextual explanations for the quantitative results and provided a more comprehensive understanding of both the educational outcomes and students' experiences of the intervention.

Setting and participants

This study was carried out at Dow Dental College, Karachi, Pakistan, Public sector Dental institution during 2025–2026 academic session. The participants were the third-year undergraduate students of the Bachelor of Dental Surgery (BDS) programmed.

Universal sampling was used to invite all 50 eligible students from the 3rd year cohort. Students were eligible if they were enrolled in the third year of the BDS program during the study period. For the quantitative analysis, students were excluded if they missed either instructional session or its corresponding assessment, or if their overall attendance was below 75%. Since the total accessible population of 50 students were used, no separate sample size calculation was required. Transparency was reported regarding participant recruitment, allocation, attendance and analysis of participants.

Study duration

The study was approximately six months long, involving the development and testing of tools, faculty preparation, teacher recruitment and randomization, instructional sessions, immediate assessments, delayed assessments, qualitative data collection, analysis, synthesis of results, and final reporting

Randomization and allocation

After informed consent, the 50 students who volunteered to participate were randomly assigned to the 2 groups (25 were assigned to the Jigsaw group and 25 were assigned to the traditional lecture group) using a simple lottery-based method.

The two groups received two instructional sessions conducted one week apart, with each session lasting approximately two hours. Attendance was taken in both sessions. The quantitative analysis included only those students who attended both instructional sessions and completed the assessments. Sixteen students in each group fulfilled these criteria, for an analyzed sample of 32 students (Jigsaw, $n = 16$; traditional lecture, $n = 16$).

Intervention

The teaching content was Sampling Techniques which was a part of course of third-year BDS Community Dentistry subject. The topic was chosen because it was already part of the planned curriculum and could be broken down into subtopics that were discrete but interconnected so that it could be taught in the Jigsaw cooperative learning model.

Jigsaw group

Students allocated to the Jigsaw group were organized into four home groups of four students each. Within each home group, students were assigned to one of four expert groups using facilitator-generated random numbers (1–4). Each expert group was assigned a specific subtopic.

Students in the expert groups collaboratively reviewed their assigned material through discussion and textbook consultation and synthesized the key concepts. They subsequently returned to their respective home groups and taught their assigned subtopics to their peers. This process ensured that each student contributed to the learning of the group and participated in peer teaching. (Fig. 1)

Two trained facilitators supervised the Jigsaw sessions. Their job was to oversee the activities of the group, to facilitate discussion, to clarify questions and to ensure that group learning goals were met without substituting the peer-teaching process for conventional teacher-guided learning.

Traditional lecture group

Students allocated to the traditional lecture group received a conventional didactic lecture covering the same content and learning objectives as the Jigsaw group. The instructional duration was equivalent to groups. The lecture was presented by one of the teachers without any small group or peer teaching activities.

The intervention was provided two weeks in a row. Probability sampling was covered during the first week and non-probability sampling during the second week. The same pre-test, instructional intervention, and immediate post-test sequence were followed for both groups in each session.

Outcome measures and assessment procedure

Knowledge was assessed using investigator-developed one-best-answer multiple-choice questions (MCQs) based on the prescribed curriculum and learning objectives. A 15-item pre-test was administered immediately prior to each instructional session, and a 15-item immediate post-test was administered at the end of the session in the last 15 minutes. The same items were used for both assessments. A 30-item delayed post-test covering both sessions was administered four weeks after the second session to assess knowledge retention. The four-week period was chosen to assess learning over a delay of a few weeks after instruction, consistent with previous medical education research.

MCQs were developed by the principal investigator according to the course syllabus and learning objectives. Face and content validity were assessed by two subject-matter experts, including the Head of Department and an Assistant Professor experienced in the relevant subject and MCQ development. The suggestions made about wording, format, timing, and scoring for items were considered in the final instruments.

Qualitative data collection

Following the quantitative assessment, two focus group discussions (FGDs) were conducted with voluntarily recruited students from the Jigsaw group. Each FGD included four to six students, lasted approximately 45–60 minutes, and was conducted in a quiet setting. The principal investigator organized the discussions, with a semi-structured guide to help students share their ideas about learning, engagement, peer interaction, participation, challenges, and feasibility. Discussions were recorded and transcribed verbatim, with the students' permission. Codes were used to identify the participants. Data collection ended when subsequent discussions generated recurring codes without substantially new concepts.

Quantitative data analysis

IBM SPSS Statistics version 24.0 was used to analyze the data. Means and standard deviations were presented for continuous variables and frequencies and percentages for categorical variables. Skewness and kurtosis z-scores were used to assess score distributions and values between -1.96 and $+1.96$ were deemed to be approximately normally distributed. Within group comparisons of pre-test and immediate post-test scores were made using paired-samples t-tests, and independent-samples t-tests were used for comparisons of two groups (Jigsaw and Traditional lecture) for delayed retention test scores. The equality of variances was tested using Levene's test. A p value < 0.05 was considered significant.

Qualitative data analysis

Thematic analysis, as proposed by Braun and Clarke, was used to analyze FGD transcripts. Transcripts were repeatedly reviewed, inductively coded, and grouped into categories and themes. Themes were reviewed and refined in discussion with the academic supervisor and co-supervisor to enhance analytic credibility. Transcript review for accuracy was provided for participants. The quantitative and qualitative results were then combined and analyzed for the convergence and divergence.

Ethical considerations

Ethical approval

was provided by the respective Institutional Review Board of Dow University of Health Sciences with IRB Ref No-3991/DUHS/Approval/2025/206. The study was conducted in accordance with the principles of the Declaration of Helsinki. All participants gave informed written permission. All participation was voluntary with no academic repercussions for withdrawal. Confidentiality and anonymity were maintained, and data were securely stored for research purposes. After completion of the study and assessments, control-group students were offered a Jigsaw learning session.

Results

Participant flow and analysis population

Fifty third-year BDS students were enrolled, with 25 assigned to each group. Complete pre-test and immediate post-test data were available for 32 students (16 per group). Three extreme observations were identified during preliminary screening and excluded from the relevant parametric analyses, leaving 29 paired observations. The one-month retention assessment was completed by 34 students (17 per group). Analyses were therefore performed according to the available data for each outcome.

Quantitative outcomes

All continuous variables were found to be approximately normally distributed with standardized skewness and kurtosis values within ± 1.96 . Baseline knowledge doesn't show any significances between the Jigsaw and Traditional Lecture groups (7.45 ± 3.32 vs. 7.52 ± 3.25 ; $t(28) = -0.083$, $p = 0.935$).

There was significant pre-test to immediate post-test gains for both groups. Scores increased from 7.45 ± 3.32 to 13.79 ± 1.24 in the Jigsaw group (mean change = 6.34; $t(28) = -10.36$, $p < 0.001$) and from 7.52 ± 3.25 to 13.31 ± 1.51 in the Traditional Lecture group (mean change = 5.79; $t(28) = -10.26$, $p < 0.001$). There was no significant difference between the between-group means (mean difference = 0.48; $t(28) = 1.15$, $p = 0.260$) (Table 1) for the immediate post-test.

Mean retention scores were 10.88 ± 2.93 in the Jigsaw group and 10.53 ± 2.84 in the Traditional Lecture group at 1 month. The between-group difference was not statistically significant (mean difference = 0.35; $t(32) = 0.506$, $p = 0.616$). Levene's test indicated homogeneity of variance ($p = 0.861$) (Table 2).

Qualitative findings

The focus group discussions explored students' experiences and perceptions of the Jigsaw learning method. Thematic analysis generated five themes: (1) enhanced engagement and learning, (2) development of communication, confidence and teamwork, (3) need for teacher facilitation and structured guidance, (4) perceived advantages over traditional lecture-based teaching, and (5) satisfaction and motivation. The themes, subthemes, and representative participant quotations are presented in Table 3

Enhanced engagement and learning

Students described the Jigsaw activity as engaging and interactive and perceived it as helping them maintain attention during the learning session. Participants compared this experience with traditional lectures where they noted that they became distracted after a certain amount of passive listening. One participant explained.

We understand a lecture for 10–15 minutes, then there comes a time when we zone out. In this activity we had to stay alert.

Participants also perceived the Jigsaw approach as supporting understanding and retention. They believed that this was due to "active discussion", "peer explanation", and "engagement in learning

process, not just receiving information. One participant stated:

There was a lot of retention... I did not have to read it from anywhere because I remembered it.

The peer-led format was also described as creating a comfortable environment for interaction and communication. One student noted:

Friends are sitting in a circle and talking to each other... our mode of communication becomes very easy.

Overall, students perceived the Jigsaw activity as facilitating sustained attention, active engagement, and a comfortable peer-learning environment.

Development of Communication, Confidence and Teamwork

Students identified reciprocal teaching as an important feature of the Jigsaw activity. Taking responsibility for explaining concepts to peers was perceived as increasing confidence and encouraging greater preparation. One participant stated:

Because of this, my confidence boosted... your responsibility increases because you have to make your fellows understand.

Participants also identified opportunities for communication development through the process of explaining ideas, answering questions, listening to others, and thinking about other perspectives. One student highlighted:

Listening to others' opinions... is also a big skill.

Random allocation to groups required students to collaborate with classmates outside their usual social circles. The experience was generally satisfactory and participants felt that it helped to foster interaction, cooperation and inclusiveness. One participant said that it was like:

"It was a positive vibe... everyone was comfortable."

Another participant highlighted:

Making new friends...it was a very good experience; it was with random people.

Therefore, pupils saw Jigsaw as an opportunity to practise reciprocal teaching and for communicating, being confident and taking part cooperatively.

Teacher facilitation and structured guidance:

Students appreciated peer learning but understood that the model of using peer explanations alone had some drawbacks. Participants acknowledged that differences in knowledge between students and teachers could create a risk of misconceptions being shared or reinforced. One participant commented:

A student has very limited knowledge as compared to a teacher.

Another expressed concern that an incorrect explanation could continue to be accepted by peers:

I thought it was wrong... they will always think the same way.

Hence, students spoke about the need for supervision by faculty during Jigsaw activity. They proposed that teachers should go between groups, watch the groups talk, correct misconceptions, and guide as needed. One participant stated:

There was a need for increased supervision.

Another commented:

Without the teacher, this method can't work.

Participants also raised issues about factors such as group size, time available and preparation prior to the session. One student cautioned:

A student has very limited knowledge as compared to a teacher.

Students suggested that learning topics should be provided in advance to allow adequate preparation and that additional time should be allocated for consolidation or revision. One participant emphasized the need to:

There should be a 15-minute brainstorming or revision at the end.

Based on the findings, students saw that faculty facilitation and structuring the classroom appropriately were important for the implementation of the Jigsaw method.

Advantages Over Traditional Lecture-Based Teaching

Students made the comparison between the Jigsaw method and the conventional lecture method in a clear manner. Traditional lectures were defined as having an *"extensive note taking"* and relatively passive interaction with the content. One participant explained:

In lectures we write notes, but we are not really grasping the knowledge.

In contrast, the Jigsaw method was described by students as "active learning", and they highlighted discussion, explanation, interpretation and participation. Peer-generated examples also were found to be helpful for understanding concepts. One participant stated:

We gave examples to each other... so I understood it very well.

Participants further described peer explanations as useful when concepts were communicated using familiar language and relatable examples. Students reported that Jigsaw gave a more interactive and

context-rich learning experience as compared to traditional lectures, as shown in these accounts.

Satisfaction and Motivation

The students' overall feedback on the Jigsaw activity was that it was fun, engaging and challenging. They reported being engaged throughout the activity and less fatigue with using this approach than with traditional teaching. One participant stated:

We never felt exhausted for even a second.

Participants also wanted to use the Jigsaw approach more in their teaching in the future. One student commented:

This type of activity should be done more often so we feel like coming to class.

The students' responses indicated their positive attitude towards the learning experience and their readiness to engage in such interactive learning activities in the future.

Overall, the qualitative findings indicate that students perceived Jigsaw learning as an engaging and collaborative approach that facilitated peer interaction, confidence, communication, and active participation (Fig. 2). Students also highlighted the need for faculty facilitation, proper preparation, limited group sizes, and enough time for consolidation to help with effective implementation.

Table 1
Baseline and immediate post-test knowledge scores

Comparison	N	Mean $\pm$ SD	Mean Difference	T	df	P-value
Baseline pre-test						
Jigsaw	16*	7.45 $\pm$ 3.32	-0.07	-0.083	28	0.935
Traditional Lecture	16*	7.52 $\pm$ 3.25				
Immediate post-test						
Jigsaw	16*	13.79 $\pm$ 1.24	0.48	1.15	28	0.26
Traditional Lecture	16*	13.31 $\pm$ 1.51				
Within-group change						
Jigsaw pre-test vs. post-test	29 [†]	7.45 $\pm$ 3.32 $\rightarrow$ 13.79 $\pm$ 1.24	-6.34	-10.36	28	< 0.001
Traditional Lecture pre-test vs. post-test	29 [†]	7.52 $\pm$ 3.25 $\rightarrow$ 13.31 $\pm$ 1.51	-5.79	-10.26	28	< 0.001
SD: Standard Deviation; df: Degrees of Freedom. * Sample size per group before outlier removal ($n = 16$ per group; $N = 32$ total). [†] Based on the post-outlier paired-analysis sample ($N = 29$; $df = 28$). P-values < 0.05 indicate statistically significant differences.						

Table 2
Delayed Post-Test (Retention) Knowledge Scores Between Groups

Group	N	Mean ± SD	Mean Difference	T	df	P-value
Jigsaw	17*	10.88 ± 2.93	0.35	0.506	32	0.616
Traditional Lecture	17*	10.53 ± 2.84				
<i>Note: SD = Standard Deviation; df = Degrees of Freedom.</i>						
<i>* Sample split evenly (n = 17 per group; total N = 34; df = 32).</i>						
<i>Independent-samples t-test, two-tailed; equal variances assumed. Levene's test, p = 0.861.</i>						

Table 3: Themes, Subthemes, and Representative Quotations from Focus Group Discussions

Theme	Subtheme	Representative Quotes
Enhanced Engagement and Improved Learning	Increased Attention and Reduced Zoning Out	"We understand a lecture for 10–15 minutes, then there comes a time when we zone out. In this activity we had to stay alert."
	Improved Retention and Understanding	"There was a lot of retention... I did not have to read it from anywhere because I remembered it."
	Comfortable Peer-Led Learning Environment	"Friends are sitting in a circle and talking to each other... our mode of communication becomes very easy."
Development of Communication, Confidence and Teamwork	Increased Confidence Through Teaching Others	"Because of this, my confidence boosted... your responsibility increases because you have to make your fellows understand."
	Enhanced Communication Skills	"Listening to others' opinions is also a big skill."
Need for Teacher Facilitation and Structured Guidance	Limitations of Peer Knowledge	"A student has very limited knowledge as compared to a teacher."
	Need for Faculty Supervision	"Without the teacher, this method can't work."
	Structural Improvements Suggested	"There should be a 15-minute brainstorming or revision at the end."
Advantages Over Traditional Lecture-Based Teaching	Active Learning	"In lectures we write notes, but we are not really grasping the knowledge."
	Peer-Relevant Examples	"We gave examples to each other... so I understood it very well."
Satisfaction and Motivation	Enjoyable Learning Experience	"We never felt exhausted for even a second."
	Increased Motivation to Attend Classes	"This type of activity should be done more often so we feel like coming to class."

Discussion

This current mixed-methods study compared the effectiveness of the Jigsaw method of cooperative learning with the Traditional Lecture method in terms of gaining knowledge, knowledge retention, and students' perceptions among third-year dental students in a public sector university. The quantitative findings of the present study demonstrated that both Jigsaw and Traditional Lecture methods resulted in statistically significant improvement in immediate post-test scores, indicating that both approaches were effective for short-term knowledge acquisition. Similar findings have been reported in previous studies, where structured teaching, whether lecture-based or cooperative, has led to improved immediate academic performance [1, 16, 17].

However, unlike studies that reported significantly higher immediate post-test scores with the Jigsaw method [15, 16, 18], the current study found comparable short-term gains between the two groups. This variation may be attributed to differences in study context, duration of intervention, small sample size, instructional content, and assessment methods, as highlighted in earlier research [1, 7]. These findings suggest that while the Jigsaw method is effective for facilitating learning, its advantage may not necessarily lie in immediate knowledge gain when compared with a well-structured traditional lecture.

In contrast to findings reported in few earlier studies, which demonstrated superior long-term retention with the Jigsaw method [18, 19], the present study found no statistically significant difference in delayed post-test scores between the Jigsaw and Traditional Lecture groups. Both groups retained knowledge at comparable levels four weeks after instruction.

Previous literature suggests that enhanced retention with Jigsaw learning is often associated with repeated exposure, extended implementation, and reinforcement of cooperative learning strategies rather than short-term or single-session interventions [7, 16]. The absence of a significant retention difference in this study may therefore be related to the limited duration of the intervention, reduced sample size in the delayed assessment, or the influence of external learning activities during the follow-up period.

These findings highlight the importance of cautious interpretation and suggest that short-term implementation of cooperative learning alone may not be sufficient to produce measurable long-term retention benefits.

The qualitative findings revealed that students perceived the Jigsaw method as engaging, motivating, and supportive of collaborative learning. The themes identified were enhanced engagement, improved communication and teamwork, need for teacher facilitation, advantages over lectures, and increased motivation are consistent with previous qualitative and mixed-method studies [7, 17, 20].

Students' emphasis on the importance of faculty guidance and structure aligns with findings that noted that effective facilitation is essential for the successful implementation of cooperative learning strategies [1, 15]. These findings reinforce the view that while Jigsaw learning promotes active participation, instructor involvement remains critical to ensure meaningful learning.

The integration of quantitative and qualitative data suggests that although no clear superiority of the Jigsaw method was observed in long-term knowledge retention, the method was positively perceived by students and contributed to the development of important professional skills. Similar conclusions have been reported in earlier mixed-methods studies, where learner satisfaction and skill development were emphasized despite variable academic outcomes [7, 15, 16].

These findings support that educational effectiveness in health professions education should not be limited to examination performance, but also include learner engagement, collaboration, communication, and quality of the learning experience.

Strengths of the Study

The mixed-methods design combined objective measures of immediate knowledge gain and delayed retention with a qualitative exploration of students' experiences. The intervention was conducted in a real classroom context, thus increasing the educational relevance and providing practical insights into how to implement Jigsaw learning in dental education.

Study Limitations

The generalizability of the findings could be limited by the single-institution setting and relatively small sample. Student independent learning during the follow-up period may also have influenced knowledge retention. The short duration of the intervention limits conclusions regarding longer-term effects, and successful implementation of Jigsaw learning may depend on adequate faculty facilitation, preparation, and classroom organization.

Conclusion

From the results of the present study, it can be inferred that the Jigsaw method as well as the Lecture method have been proved to be effective in enhancing the short-term knowledge of undergraduate dental students. No significant difference in the long-term retention of knowledge between the two types of teaching. Despite the findings, students felt the Jigsaw method was useful in improving engagement, communication, teamwork and motivation. The results indicate that the Jigsaw method can be effective in teaching dental education without replacing lectures.

Recommendations

The Jigsaw method is recommended to be used in addition to the conventional teaching method to boost students' sense of engagement and collaboration. It is also recommended that faculty development programs on effective facilitation of cooperative learning be conducted.

Consequently, the following suggestions for further research are longitudinal and repeated study and application of the Jigsaw approach, larger samples in multi-centers, and evaluation of the effects on clinical reasoning and job skills in dental education should be considered in future studies.

Abbreviations

BDS

Bachelor of Dental Surgery

DUHS

Dow University of Health Sciences

FGD

Focus group discussion

IRB

Institutional Review Board

MCQ

Multiple-choice question

SD

Standard deviation

SPSS

Statistical Package for the Social Sciences

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from Dow University of Health Sciences with IRB Ref No-3991/DUHS/Approval/2025/206. The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment. Participation was voluntary, and students were informed that they could withdraw from the study without academic penalty.

Consent for publication

Not applicable. No individual-level identifying information, images, or other identifiable personal data are reported in this manuscript.

Competing interests:

The authors declare that they have no competing interests.

Funding:

No specific funding was received for this study.

Author Contribution

A.S. conceived and designed the study, developed the intervention and assessment tools, collected the data, and contributed to data analysis and interpretation. T.S., S.F., and S.K.A. contributed to study supervision, qualitative data analysis, interpretation of findings, and critical revision of the manuscript. All authors contributed to the manuscript, approved the final version, and agreed to be accountable for the work.

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Data Availability

The data sets generated and/or analyzed during the current study are not publicly available because they contain participant-level educational data and cannot be openly shared without compromising participant confidentiality. The data is available from the corresponding author on reasonable request, subject to applicable institutional and ethical restrictions.

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Figures

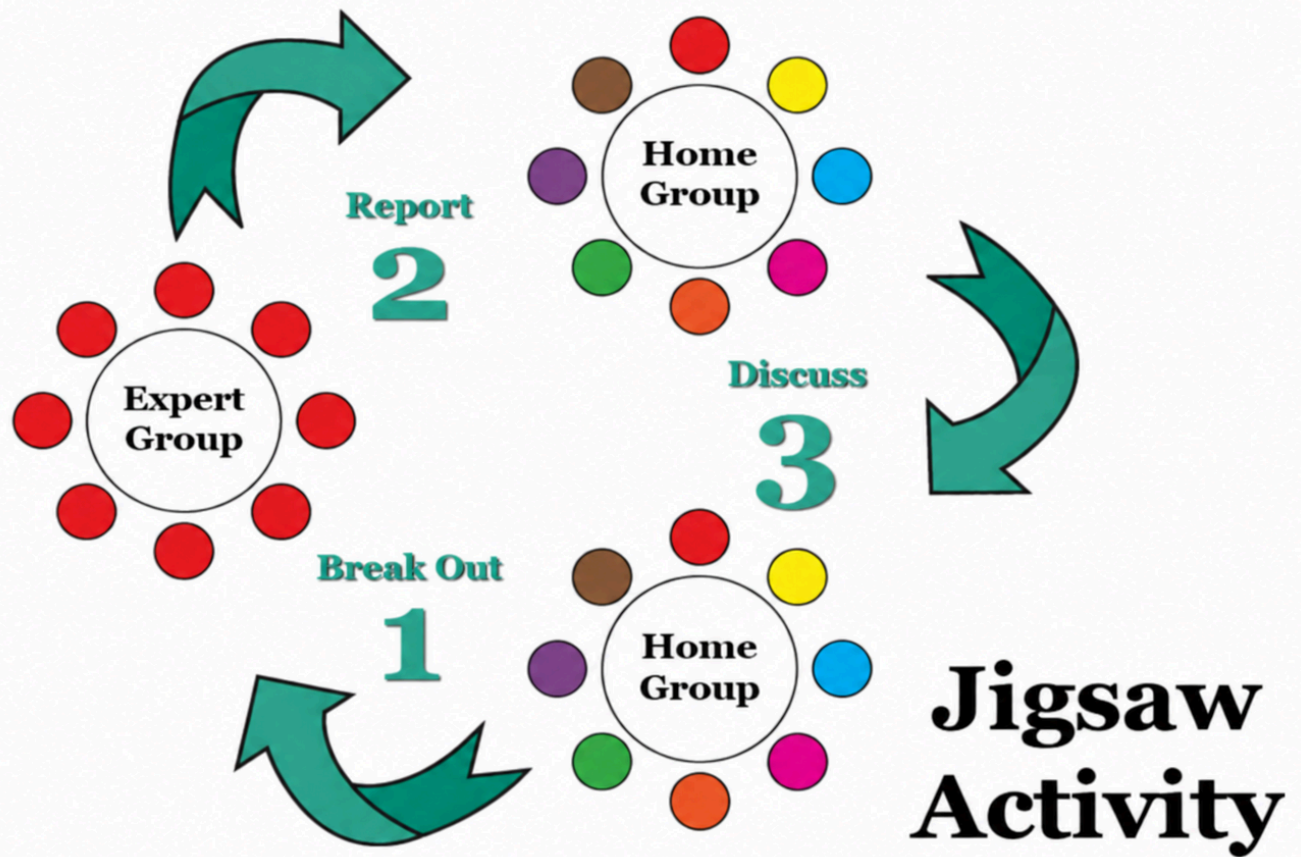


Figure 1: Process of the Jigsaw Cooperative Learning Activity

Figure 1

See image above for figure legend

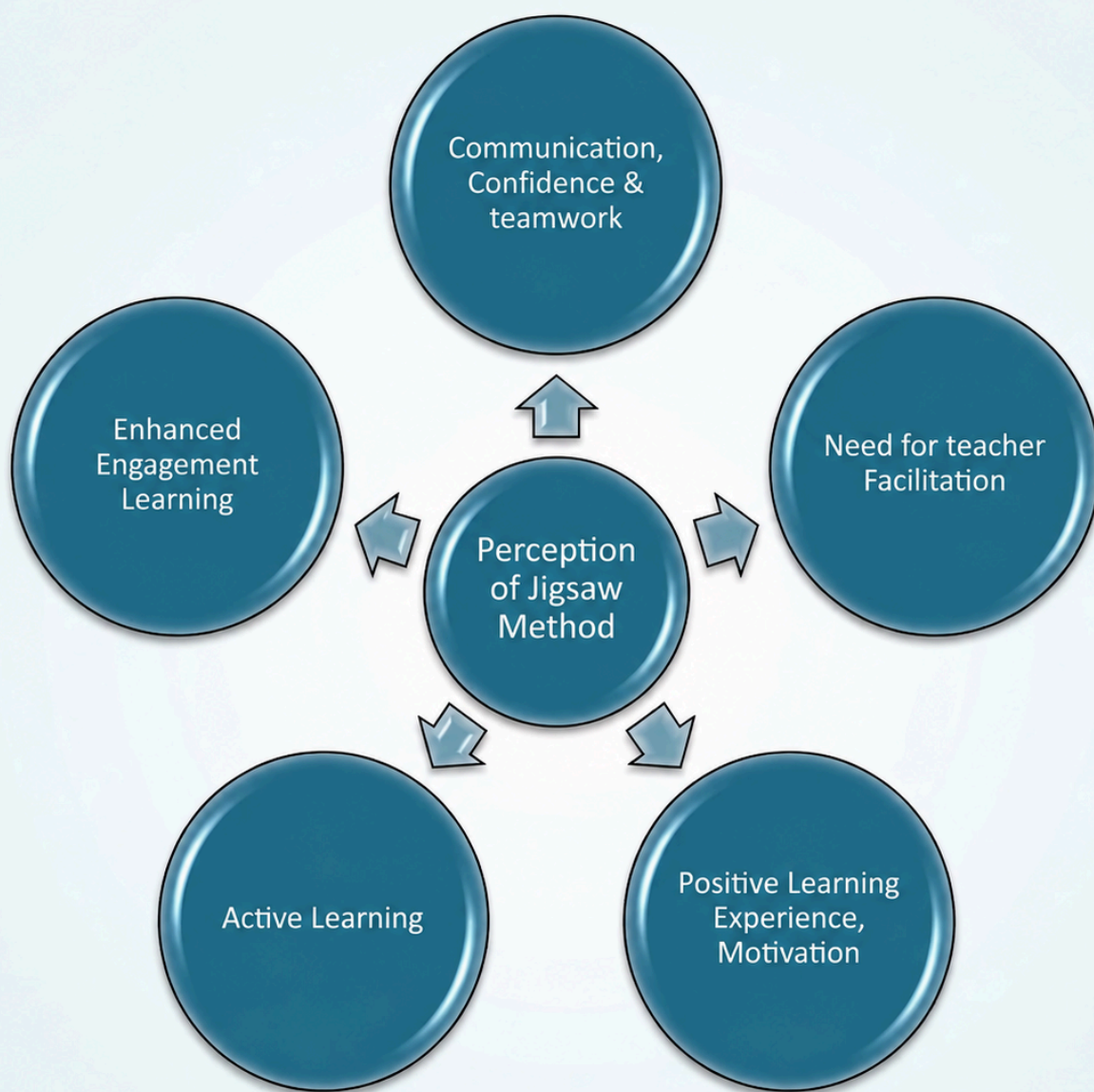


Figure 2: Student's Perception of Jigsaw Method

Figure 2

See image above for figure legend