Effects of the Jigsaw Formative Assessment Technique on Primary Grade Students' Academic Achievement in General Science

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Abstract

The study aimed to examine the impact of the Jigsaw formative assessment technique on students' academic achievement in General Science at the primary level. A quantitative, quasi-experimental design was used. The study was conducted at Government Boys Primary School, Burewala. A sample of 30 students was selected to represent the population. An achievement test of 30 questions was developed:10 knowledge, 10 comprehension, and 10 application items. A total of 15 lesson plans and tests were prepared by the researcher. Pretests and post-tests were administered to measure achievement gains. Data were analyzed using SPSS and an independent sample t-test. Results showed a significant difference between pretest and post-test scores ($p < 0.05$, Cohen's $d = 0.82$), indicating a large effect. Post-test scores were higher for all students after Jigsaw instruction. Significant improvements were found in knowledge ($p < 0.05$, $d = 0.78$), comprehension ($p < 0.01$, $d = 0.85$), and application ($p < 0.05$, $d = 0.80$) levels. These results confirmed the positive and strong impact of Jigsaw on learning. It is recommended that teachers apply Jigsaw formative assessment to enhance student achievement in General Science. The findings imply that incorporating collaborative learning strategies like Jigsaw can foster deeper understanding, promote peer interaction, and make science instruction more engaging and effective in real classroom settings.

Keywords: *Jigsaw, Formative Assessment Technique, Comprehension, Application, Primary School Level, Students' academic achievement. General Science*

Introduction

The Jigsaw is a cooperative-learning approach established by social psychologist Elliot Aronson in 1971 to develop cultural pressures in combined schoolrooms by emerging interdependence and mutual appreciation. In this technique, students are placed into heterogeneous "home groups," and each fellow is allocated a separate portion of the lesson. They then join "expert groups" composed of peers studying the same topic

unit, master the material, and afterward return to their home groups to teach what they've learned. The name "Jigsaw" reflects how each student's involvement is vital—like a puzzle piece important to finishing the whole picture—promoting liability and supportive engagement. Research and practical applications across education levels constantly highlight its advantages: enhanced academic achievement, improved communication skills, deeper content comprehension, and stronger peer associations (Jacobs & Legiralde, 2025).

The Jigsaw supportive knowledge model remains a strong and progressively useful educational approach. Recent meta-analyses support its positive effects: in

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nursing education, Jigsaw significantly expands academic achievement, personal skills, inspiration, critical thinking, and self-confidence associated with traditional methods. Among undergraduate medical students, the Jigsaw technique improves academic performance and is positively received by both students and faculty, mostly for developing helpful interrelationships and personal engagement (Tahir & Patak, 2025).

Cooperative learning is a teaching method where students work together and take an active role in learning. In this approach, students are placed in small groups to complete a specific task. All cooperative learning models share a few key elements, such as teamwork, shared responsibility, and active participation. Other student-centered teaching methods include group discussions, practical activities, concept mapping, problem-solving, inquiry-based learning, role-playing, peer teaching, fieldwork, independent projects, library work, computer-assisted learning, and homework. (Triansyah, Suwatno, & Machmud, 2023).

Generally speaking, Cooperative learning is often seen as one main teaching method, but it actually includes many different strategies. One well-known example is the Jigsaw formative assessment technique. In this approach, the main class group is divided into smaller "jigsaw groups," just like pieces of a puzzle. Each jigsaw group is made up of students from different main groups, and they work together to study the same topic. After learning in their jigsaw group, students return to their main group and teach their group members what they have learned.

For many years, both individual and group-based learning methods have been used in classrooms at all levels, from primary to higher education. Traditional learning theories, like behaviorism and cognitivism, focused mainly on individual abilities. However, in recent years, there has been more attention on social development as an important part of learning. Research shows that social interaction in the classroom plays a key role in students' thinking skills, and cooperative learning can often improve academic achievement more effectively than learning alone (Dewanto, Wantu, Dwihapsari, Santosa, & Agustina, 2023).

This is among the collaborative learning strategies whereby the lesson content is differentiated into several pieces of information akin to a jigsaw puzzle, after which it is distributed to groups of students who would later provide reports to one another about their pieces, eventually resulting in the actuality of a complete jigsaw puzzle in its totality. Jigsaw cooperative learning strategy is a well-developed lesson plan well developed strategy that was first initiated by Aronson. The instructor presents the most important topic, or in other words, the subject matter, and any of its subtopics with the help of the Jigsaw method. After that, all the learners are separated into home groups, and the individual followers of each group receive a different subtopic. So that the students can freely form so-called expert groups, in which they focus only on one subtopic and conduct research and debate, in the second step, they need to break their home groups. Consequently, the students learn professional knowledge regarding the assigned subtopic. Following their discussions, all the students of the expert group will be required to revert to their groups and teach their colleagues according to what they have learnt and talked about. Each of the members of the home groups will have ultimately learned through the discussion among experts of each group, to learn

through the other groups. Multiple studies conducted before have retained the effectiveness of the jigsaw cooperative learning strategy (Cochon, Kaestner, & Margas, 2023).

Jigsaw formative assessment is a supportive technique where learners become "experts" on subtopics in temporary groups and then teach their home teams; teachers embed ongoing checks, peer feedback, brief quizzes, and observation rubrics to monitor progress and adjust instruction. Recent evidence supports its impact: a meta-analytic review reported overall gains in key educational outcomes when Jigsaw was used, including achievement and interpersonal skills. In different studies, science courses have found Jigsaw associated with higher academic performance, stronger engagement, and a sense of inclusivity compared with typical small-group discussion. Research integrating formative assessment into flipped Jigsaw lessons also showed improved learning engagement, highlighting the value of continuous feedback within the structure. Broader syntheses further describe Jigsaw's mechanisms of positive interdependence and individual accountability as key drivers of its effectiveness (Kekeba, Gure, & Olkaba, 2025).

Statement of the Problem

The Jigsaw formative assessment technique is an assessment technique that helps students develop better thinking skills, improve creativity, and move away from simple memorization. Instead of learning facts by heart, students understand the concepts more deeply because they work together, explain ideas to each other, and take an active part in the learning process. At the primary level, General Science is one of the most important subjects, as it helps children understand the world around them and builds a foundation for future learning. However, students can only fully grasp science concepts when their understanding is strengthened through engaging and interactive methods. Traditional teaching methods often focus on memorization, which may limit real understanding. The Jigsaw assessment technique changes this by separating a topic into minor parts and allocating each student a specific section to learn and later teach to their peers. This encourages responsibility, teamwork, and deeper comprehension.

The present study was planned and conducted to investigate how using the Jigsaw formative assessment technique affects students' academic achievement in General Science at the primary school level. The aim was to determine whether this approach could lead to better understanding, improved learning outcomes, and higher achievement compared to traditional methods.

Objectives of the Study

The objectives of the study were

1. To find out the effect of the jigsaw formative assessment technique on primary grade students' academic achievements in general science by comparing the pre-test of the control and experimental groups.
2. To find out the effect of the jigsaw formative assessment technique on primary grade students' academic achievements in general science by comparing the post-test of the control and experimental groups.

Research Hypotheses

Ho1: There is no significant effect of the Jigsaw formative assessment technique on primary grade students' academic achievements in general science by comparing the pre-test of the control and experimental group.

Ho2: There is no significant effect of the Jigsaw formative assessment technique on primary grade students' academic achievements in general science by comparing the pre-test of the control and experimental groups.

Significance of the Study

This study aims to show the value of the Jigsaw formative assessment technique in the teaching and learning process. The method focuses on helping students develop a strong understanding of concepts rather than relying only on memorization. By working in groups and sharing knowledge, students can learn more effectively and improve their communication and teamwork skills. For teachers, the findings of this study can offer new ideas to improve their teaching methods and make lessons more engaging. The results can also guide them in using more interactive and student-centered strategies in the classroom. In addition, this study will be useful for researchers who are exploring effective learning techniques, psychologists who study how students learn, and policymakers who make decisions about educational practices. Schools can also benefit from the insights of this research to enhance teaching quality and improve students' academic performance at the primary level.

Literature Review

In the Jigsaw cooperative strategy, students are placed in small groups, usually with five to six members. Each student is assigned a specific topic to study in depth, becoming an "expert" on that part. After learning their section, students share their knowledge with the rest of the group, ensuring that everyone understands the complete lesson (Moin, Zafar, Nadeem, & Majeed, 2024).

The Jigsaw formative assessment technique is important in primary-grade general science because it promotes active learning, collaboration, and deeper understanding of concepts. By dividing a topic into smaller parts and assigning each student to become an "expert" in one part, children develop responsibility for their own learning while also teaching peers. This process not only strengthens subject comprehension but also builds communication and teamwork skills. In general science, where concepts can be abstract for young learners, the Jigsaw method encourages engagement through peer explanation and discussion, making learning more meaningful. The formative assessment aspect, through teacher observation, questioning, and peer feedback, helps identify misconceptions early and provides timely support. Research has shown that such cooperative approaches significantly improve primary students' academic achievement, retention, and confidence, enabling them to perform better in assessments and apply scientific knowledge in practical situations (Abobaker, Sulaiman, Alshaery, & Mansour, 2023).

The effectiveness of this method depends greatly on teamwork and active participation from all members. Every student's contribution is important because the group's success relies on each person explaining their topic clearly and accurately. More broadly, cooperative learning means students working together to achieve common learning goals. It also includes teaching strategies that are designed to

organize and guide these group efforts. This approach not only helps students understand the subject better but also improves their communication, problem-solving, and collaboration skills, which are valuable for lifelong learning (Kim & Kim, 2019).

Cooperative learning is a teaching method that has been used in classrooms for many years. It is based on the constructivist theory, which suggests that students learn best by actively building their own understanding through interaction and experience. In its early form, cooperative learning simply involved students working together in pairs or small groups to complete tasks. Over time, the approach has developed into more structured methods that encourage deeper participation and collaboration. Research has shown that cooperative learning can be highly effective in improving students' understanding of various subjects. When teachers carefully plan and provide clear guidance, also called scaffolding, during group activities, students are more likely to succeed. This approach not only improves comprehension but can also strengthen higher-order reading skills, such as analyzing, evaluating, and interpreting information. By working together, students benefit from sharing ideas, supporting each other, and learning in an active, engaging way (Cochon, Kaestner, & Margas, 2023).

While cooperative learning has traditionally been applied in general education classrooms, it is also highly effective when working with students who have special needs. This approach promotes inclusion by allowing all learners to participate, contribute, and benefit from shared learning experiences. Cooperative learning is a broad teaching method that includes a variety of strategies designed to encourage collaboration, communication, and mutual support among students. One well-known and evidence-based strategy within this category is the Jigsaw method. Research has shown that it can significantly improve students' understanding of lesson content. In the Jigsaw approach, each student is responsible for learning a specific part of the material and then teaching it to their peers. This process ensures that all group members depend on each other for success, creating a sense of responsibility and teamwork. By actively engaging in both learning and teaching, students not only develop deeper comprehension but also strengthen social skills, problem-solving abilities, and confidence in their own learning process (Jogezai & Bibi, 2022). According to Bigg and Stump, "For cooperative learning to be effective, students need ample opportunities to solve problems as a group first and then resort to teacher assistance."

The jigsaw method is not the only one of the cooperative learning strategies that has proved promising, yet it is not without fault when applied to assisting special education children, like the general education children.

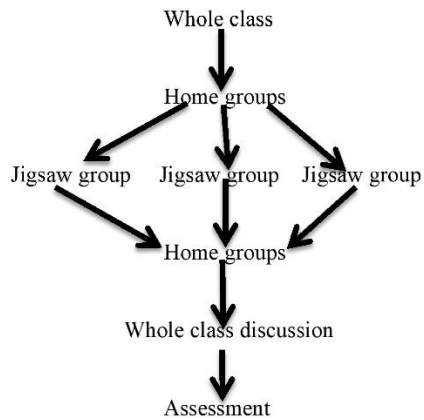
The jigsaw method was initially invented by Elliot Aronson to help in the process of enabling pupils to work on improving their social and cooperative skills. They discovered that kids were acquiring the contents of what was being practiced better, even though the original aim was to solve desegregation issues in Texas. Since that time, several works have demonstrated the extent to which it is effective in increasing the amount of knowledge in students (Silva, Lopes, Morais, & Dominguez, 2023).

Theoretical Framework of the Jigsaw Technique

The theoretical framework explains how the Jigsaw Formative Assessment Technique affects students' academic achievement in General Science. It is based on constructivist and social learning theories that stress active participation, collaboration, and feedback in learning. According to Piaget's Constructivist Theory (1970), learners build understanding through interaction with their environment. The Jigsaw method supports this by engaging students in meaningful tasks and peer discussions. Each learner takes responsibility for part of the content, promoting deeper comprehension. In the classroom, students construct new knowledge by teaching and learning from peers. This process enhances engagement, critical thinking, and long-term retention of scientific concepts.

Figure 1

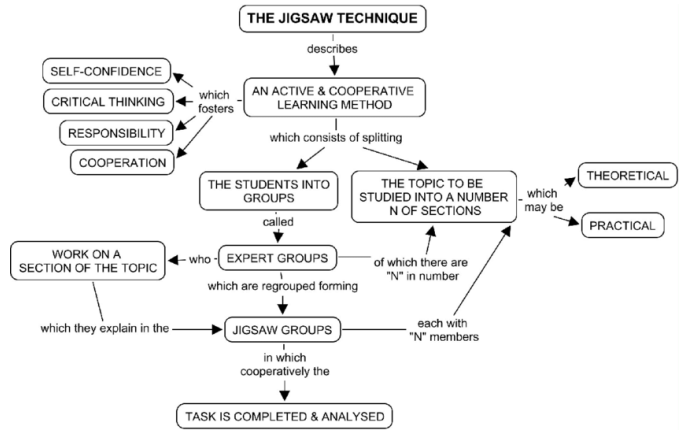
Theoretical Framework



Conceptual Framework

The study is grounded in the belief that active, collaborative, and feedback-driven learning enhances students' academic achievement. The independent variable of the study is the Jigsaw Formative Assessment Technique, while the dependent variable is students' academic achievement in General Science. In this approach, learners are divided into small groups where each member becomes an expert on a specific sub-topic and later shares their understanding with peers. This cooperative structure promotes communication, responsibility, and teamwork among students. Continuous formative assessment takes place through peer questioning, feedback exchange, and teacher observation. Guided by Constructivist Theory, learners actively construct knowledge through participation and reflection. Vygotsky's Social Constructivism emphasizes learning through interaction and scaffolding, while Cooperative Learning Theory focuses on interdependence and mutual support. Together, these theories explain how the Jigsaw technique strengthens understanding and retention. Through effective feedback and peer collaboration, students develop higher-order thinking, problem-solving, and scientific reasoning skills. Ultimately, the application of the Jigsaw Formative Assessment Technique is expected to significantly improve primary-grade students' achievement in General Science.

Figure 2
Conceptual Framework



Research Gap

Although numerous studies have examined the effectiveness of the Jigsaw technique as a cooperative learning strategy, limited research has explored its role specifically as a *formative assessment technique* at the primary school level, particularly in the subject of General Science. Most existing studies focus on secondary or higher education contexts and emphasize collaboration rather than the formative aspects, such as feedback, peer assessment, and evidence-based improvement of learning. Furthermore, only a few studies have investigated how the Jigsaw approach enhances conceptual understanding and achievement when applied within formative assessment frameworks in young learners. Therefore, there remains a significant gap in understanding how the Jigsaw Formative Assessment Technique influences primary-grade students' academic achievement in General Science, especially in developing countries like Pakistan, where such innovative assessment approaches are rarely implemented or empirically tested.

There is a lack of primary-grade studies that explicitly evaluate the Jigsaw method as a formative assessment technique measuring formative mechanisms (peer/teacher feedback quality, use of assessment evidence, and short- and long-term achievement in General Science) rather than treating Jigsaw only as a generic cooperative-learning strategy (Alexander, 2020).

A few recent studies combine Jigsaw with other instructional models (flipped classroom, simulations) or examine higher education/medical settings, showing interest in integrating formative practices but little primary-grade, subject-specific research in General Science. The pattern of science learning emphasizes the elements of education and provision to students. The emphasis on learning is not limited to effort feed or stuff students with several rote concepts only, but lies in the effort so that they can make what has been studied as a provision in understanding and participating in acting the life of the surrounding community, as well as a provision for them to continue their education to a higher level. Here, it is actually emphasizing the mission of science education. Therefore, design teacher learning should be directed and focused according to the conditions and the potential

development of students so that learning is truly useful and beneficial for students (Wu, Sari, & Huang, 2024).

Advantages of the Jigsaw formative assessment technique

The strength of the jigsaw to educate pupils on things other than academic subjects is another strength of the jigsaw. It will be able to enrich them and teach them to associate the love of education, and thus increase their confidence and improvement of self-worth. The fear and unwillingness of students to act in the classroom lesson decreases in the jigsaw classroom, and self-esteem and self-confidence increase. Since the students are thinking about their future and should know how to engage in group activities, it is significant that they should learn this in high school. The jigsaw method is supported by the studies demonstrating how this method makes the kids cooperate and share ideas, common objectives, and also makes the kids feel confident. There are many positive personal qualities required to succeed in the workplace, including possession of subject matter expertise, teamworking, and being motivated by others. The jigsaw allows students with disabilities and those who are not disabled to learn new curriculum, increase their self-esteem, and develop motivational behaviors (Montazeri, Khoshkholgh, Sani, & Dolatabadi, 2022).

The last strength is the capacity of the jigsaw to reduce the levels of anxiety among the children. On the way to their academic life, a large number of students develop anxiety in a subject, in general, or in examinations. The outcomes showed that the degree of lower anxiety was exhibited by more children in a cooperative classroom due to the positive interdependence of the jigsaw method. Positive interdependence ensures that the students know that they require the two kinds of work, group work and personal work, to succeed (Nalls & Wickerd, 2023).

The Jigsaw formative assessment technique is a highly engaging cooperative learning strategy well-suited to primary-level general science instruction. In this method, students form small "home" groups, with each member assigned to research, often through short reading or hands-on investigation, a discrete piece of a broader science topic. Students then regroup into “expert” teams to deepen their understanding of their specific subtopic before returning to teach it to their home group. This structure ensures both individual accountability and collaborative synthesis, reinforcing conceptual understanding and communication skills. In the context of general science, where topics like simple ecosystems, basic physical principles, or life cycles can be broken into accessible segments, the Jigsaw technique encourages active participation, peer-to-peer teaching, and immediate informal feedback. Particularly at the primary level, this approach nurtures curiosity, improves retention of content, and cultivates foundational scientific thinking, all while allowing teachers to informally gauge understanding and guide instruction (Darabi, Karimian, & Rohban, 2025).

Limitations of the Jigsaw Formative Assessment Technique

The use of the jigsaw formative assessment technique is based on several other limitations. The first involves the input of a teacher. The opportunity of a jigsaw is limited in case the teacher fails to make clear instructions on how to implement the strategy.

According to Yu (2017), the efficacy of the jigsaw method as an instructional strategy at the primary level was evaluated between three conditions of education,

namely jigsaw, jigsaw plus additional questioning training, and instructor-guided instruction. The outcomes showed that the modalities of the jigsaw performance used by the students were merely average. The authors believe that jigsaw can become helpful under particular circumstances, as long as students are younger in age, are involved, and belong to an elementary school age. The authors argue that there are implicit and explicit cooperative learning needs of younger children, which should be fostered with the help of the right learning materials and training experts to serve as instructors, in addition to questioning and explaining. The jigsaw is seen to have little applicability with primary students because it needs more specialized training with pupils before its application as effectively as it is with older students, which may be a trial because of time restrictions and school requirements.

One more drawback of this strategy is the real data that proves the use of the jigsaw approach. As it has been mentioned before, the jigsaw approach is challenging and tedious to carry out. A study conducted to investigate the jigsaw approach revealed that students who made use of the jigsaw process scored higher than their counterparts who used a more conventional form of pedagogy. The third limitation has to do with the way in which younger students are supposed to do the jigsaw stages accordingly to the research findings (Yu, 2017).

Despite its many benefits, the Jigsaw cooperative learning method comes with notable drawbacks that teachers and researchers have identified. First, it can be very time-consuming—both in preparation and during class activities—which may make it hard to fit into tight teaching schedules. Second, uneven participation is common: some students may dominate discussions while others stay silent or disengaged, undermining the balance of the group. Third, poor group dynamics and social pressures can emerge, particularly when low-achieving students struggle to master their assigned part, sometimes leading to feelings of inadequacy or tension within the group. Fourth, logistical and supervision challenges—such as noisy classrooms, crowded spaces, or insufficient teacher monitoring—can further weaken the learning process. Lastly, if students bring incorrect or incomplete understanding into peer teaching, this can spread confusion instead of clarity, especially if the teacher doesn't intervene in time (Moonaghi & Bagheri, 2017).

In a study conducted by Smalheiser (2017), the science teachers informed seventh graders who had already used the jigsaw approach that it was going to be used. In the study, the researchers aimed to determine how the jigsaw method and one other cooperative learning technique influenced the learning of students. The outcome indicated that none of the methods improved the knowledge of some of the scientific ideas in students. Cooperative learning first emerged in the constructivist method, where emphasis is placed on the use of experience-based activities. The jigsaw method will enable students to engage and learn. The jigsaw method in the classroom setting should work as follows, according to the following statement: The students should be motivated to explain to each other what was covered in the expert team, and once they re-enter the home team, they should be motivated to be taught by their peers within the expert team. Teachers would highly welcome the method as the students will be able to teach each other. The jigsaw also enables the teacher in the classroom to act as a facilitator instead of the director, as a modern trend in education.

Application of the Jigsaw Model

Organizing a jigsaw activity is a five-step process:

1. Define the learning goal, split the lesson into 4–6 clear subtopics, and prepare short, level-appropriate materials for each part.
2. Make mixed-ability groups (4–6 students). Give each student one subtopic and a role (e.g., Timekeeper, note-taker) to ensure accountability.
3. Students with the same subtopic meet in "expert groups" to read, discuss, make a mini- summary/visual, and rehearse how they'll teach it.
4. Experts return to their home groups and take turns teaching. Peers listen, ask questions, and complete a shared organizer or notes.
5. Use a quick individual quiz and/or group product to assess understanding, then debrief what worked, rotate roles, and note improvements for next time.

Methods and Procedure

Nature of Research Study

This study used a quantitative research approach. A quasi-experimental design was followed, where participants were divided into groups for comparison, but without full random selection. This method helped the researcher measure and compare the effects of the jigsaw formative assessment technique on students' academic achievements in general science.

Population

The population for this study included all students enrolled in the 5th grade at Government Primary School, Burewala. These students were the main focus, as the research aimed to collect data through pre-test and post-test to determine the effects of Jigsaw methods on students' learning and academic performance in general science.

Sample

To make sure the population is fairly represented, ten students from class 5^{th} were selected as a sample for the study.

Research Instrument

A test was prepared with a total of 30 questions to check students' learning. Out of these, 10 questions were designed to measure knowledge level, 10 questions tested comprehension level, and the remaining 10 questions assessed application-level skills. The test was used twice: first as a pre-test before teaching began, to see what students already knew, and then as a post-test by using the jigsaw formative assessment technique, to find out how much they had learned. This method helped the researcher compare the results of the pre-test and post-test and also understand the improvement in students' knowledge, understanding, and ability to apply concepts in general science.

Data Collection

The researcher carried out hir experiment through the Jigsaw formative assessment technique in school. He conducted a test before the intervention in the form of a pretest. After that, the researcher teaches general science subjects to the students using the Jigsaw formative assessment technique for a period of 6 weeks. After the intervention, the results were compared.

Data Analysis

Analysis of the results of the pretest and post-test was done with the help of SPSS through the independent sample t-test.

Analysis of Data

Table 1

Pretest, Posttest, and Gain Score Result

	Group	N	Mean	SD	*t-value*	*p-value*
Score	Pretest	30	16.5	5.4	4.2	0.005
	Posttest	30	21.7	3.5		

Table 1 shows the t-value, p-value, mean, and standard deviation from the study results. The data prove that the Jigsaw model had a strong positive effect on students' science performance. The p-value of 0.005 means the results are statistically significant, showing the improvement was not due to chance. The t-value of 4.2 also supports this finding. Because the results were significant, the null hypothesis, which assumed that the Jigsaw model would have no effect, was rejected. This means the study found clear evidence that using the Jigsaw method improved students' academic achievement in general science.

Table 2

Pretest-Posttest Results at Knowledge Level

	Group	N	Mean	SD	*t-value*	*p-value*
Score	Pretest	30	7.8	3.2	-3.2	0.005
	Posttest	30	11.4	2.1		

Table 2 shows the pre-test and post-test results for students' knowledge level in general science. The results reveal that using the Jigsaw formative assessment method greatly improved students' performance. The average post-test score was 11.4, which is much higher than the pre-test average of 7.8. This shows clear progress in knowledge after the lessons. The t-value of 3.2 and the p-value of 0.05 mean the improvement was statistically significant and not just due to chance. Overall, the table proves that the Jigsaw method is effective in helping students increase their science knowledge and achieve better academic results.

Table 3

Pretest-Posttest Results at Comprehension Level

	Group	N	Mean	SD	*t-value*	*p-value*
Score	Pretest	30	11.7	2.5	-1.36	-.195
	Posttest	30	13	1.8		

Table 3 shows that the post-test mean score was 13, only slightly higher than the pre-test mean of 11.4. The t-value of -1.36 and the p-value of 0.195 indicate that this difference was not statistically significant. This means the improvement could have happened by chance and was not necessarily due to the Jigsaw formative assessment technique. Therefore, the method did not produce a clear or measurable change in students' comprehension level in general science. While some students may

have shown small improvements, these results suggest that, overall, the Jigsaw method did not significantly enhance comprehension skills in this specific test setting.

1. The score data in Table 1 represent the pretest, posttest, gain, and scores of students in the test. According to it, all the students raised their posttest results by adhering to instructions through the jigsaw model. The gain score indicated the influence of the Jigsaw model on the academic performance of students, yet the scientific achievement test of students.
2. As per t-value = 4.2 and p-value = 0.005, the effect of the Jigsaw model is significant on the performance of the science students in terms of the experiment. Therefore, the null hypothesis is rejected.
3. Knowledge level: The pretest and posttest presented in Table 3 show the results of the tests. According to it, all students improved in post-test scores by adhering to the instructions based on the jigsaw model. The gain score indicated the effect of the Jigsaw model in influencing the scientific achievement test of students.
4. Table 4 shows the outcomes of the pretest and posttest in the knowledge level. The mean of the posttest of 11.4 is above the 7.8, and the Jigsaw Model shows a significant effect on the academic advancement of a student at the level of knowledge in the test, as indicated by the t-value = -3.2, p = 0.05.
5. Table 5 shows the results of the understanding level pretest and posttest. According to this, all the students had increased their post-test scores, with instructions being used by adhering to the jigsaw model. This gain score indicated the effect of the Jigsaw model on the scientific achievement test of students.
6. The results of the post-test and the pretest on the knowledge level are presented in Table 6. The negative value of 1.36 and p = -.195 indicate that the posttest 13 mean was greater than 11.7 and that there was no noticeable effect of the Jigsaw formative assessment form to influence the academic capacity of the students at the level of comprehension during the test.

Discussion

The findings of this study indicate that the Jigsaw Formative Assessment Technique significantly enhanced students' academic achievement in General Science. The consistent improvement in post-test scores across all cognitive levels—knowledge, understanding, and application—suggests that the Jigsaw method not only supports content mastery but also promotes deeper conceptual understanding and problem-solving skills. These results align with constructivist and social learning theories, which emphasize active engagement and peer collaboration as drivers of meaningful learning. Through the Jigsaw process, students learned by teaching their peers, engaging in discussion, and receiving continuous formative feedback, which likely strengthened their retention and comprehension. Similar studies (Kim, 2023; Yusuf, 2022) have also reported that cooperative and formative approaches increase student motivation and achievement, reinforcing the present study's results. Thus, the Jigsaw technique proves to be an effective tool for enhancing learning outcomes and fostering a more interactive classroom environment at the primary level.

Conclusion

In conclusion, the study confirms that the Jigsaw Formative Assessment Technique positively influences primary-grade students' academic achievement in General Science. Students taught through this approach demonstrated significant improvement from pre-test to post-test across all learning domains. The technique effectively combined collaboration, feedback, and active participation, enabling learners to construct knowledge, share understanding, and apply scientific concepts confidently. Therefore, the Jigsaw Formative Assessment Technique can be recommended as an innovative and practical strategy for primary school teachers to improve students' engagement and academic performance in General Science.

Overall, the findings show that the Jigsaw method is an effective teaching strategy. It promotes active participation, peer learning, and a better understanding of concepts. As a result, students showed improved performance in knowledge, comprehension, and application tests, indicating higher academic achievement in general science.

Recommendations

1. There could be an attempt to apply the Jigsaw formative assessment method at all levels of education.
2. It can either be taught using Urdu or the mother language in the primary schools.
3. The Jigsaw Model will be effective when it is revised in textbooks.
4. Teachers can be allotted refresher courses where they will be conversant with the Jigsaw Model.
5. Use Jigsaw in tandem with a simple science experiment to reinforce conceptual knowledge.
6. Give visual teaching aids and models that are age-appropriate.
7. Make fast formative assessments following every group in the presentation.
8. Employ mixed-ability groups in nurturing peer learning and assistance.
9. Make subtopics connect to the day-to-day science experience.

Future Recommendations

1. Expand Jigsaw across educational levels: Implement the Jigsaw Formative Assessment Technique not only in primary schools but also at middle and secondary levels to promote collaborative and active learning throughout the curriculum.
2. Integrate mother-tongue instruction: Use Urdu or local languages alongside English in teaching the Jigsaw method to ensure better comprehension, especially at the primary level, enhancing student engagement and learning outcomes.
3. Teacher training and professional development: Organize regular refresher courses and workshops for teachers to familiarize them with the Jigsaw method, its formative assessment strategies, and classroom management for cooperative learning.
4. Use practical and visual aids: Reinforce conceptual understanding by combining Jigsaw with simple science experiments, visual models, and age-appropriate teaching materials that connect scientific concepts to students' daily experiences.

5. Structured formative assessment and mixed-ability grouping: Conduct quick, structured formative assessments after each group activity, and use mixed-ability groups to encourage peer learning, support weaker students, and strengthen overall academic achievement.

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