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Impact of the Think-Pair-Share Instructional Strategy on Secondary School Students' Academic Retention in Chemistry

Franklin Nnanna Ibe
Nwafor Orizu College of Education Nsugbe, Anambra State, Nigeria

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ABSTRACT

Background: Academic retention in Chemistry remains a persistent challenge in Nigerian secondary schools, particularly in abstract topics such as acids, bases, and acid–base reactions, where conventional lecture methods often limit long-term understanding. **Objective:** This study examined the effect of the Think–Pair–Share (TPS) instructional strategy on senior secondary school students' academic retention in Chemistry and determined whether gender influenced retention outcomes. **Method:** A quasi-experimental design was employed. The population comprised 5,714 SS1 Chemistry students in Anambra State, from whom 192 were selected using stratified and simple random sampling. The Chemistry Retention Test (CRT), validated by experts, served as the data-collection instrument. Reliability was established using the Kuder–Richardson Formula 20, yielding an internal consistency coefficient of 0.81. The mean and standard deviation addressed the research questions, and ANCOVA tested the hypotheses at the 0.05 level. **Result:** Students taught using TPS demonstrated significantly higher retention scores than those taught through the lecture method. No significant gender difference was found within the TPS group. **Conclusion:** TPS enhances long-term retention in Chemistry regardless of gender. **Contribution:** The study provides empirical evidence supporting TPS as an effective strategy for improving retention in secondary school Chemistry.

1. INTRODUCTION

Science is the study of the natural world using the scientific method. It is acquired by systematic investigation of the natural environment. The application of scientific knowledge to the environment led to the development of technology. Science and technology are the bedrock for national development. Science and technology have led to massive growth (Kwelle et al., 2023). Such growth and development occur in the areas of electricity, transport, medicine, agriculture, and all of man's inventions, which are products of science and technology. The importance of science and technology to national development in any country cannot be overemphasised, as knowledge and skills in these fields are vital for the sustained development of any society (Muogbo et al., 2025). The future of every society will be determined by citizens who can understand and help shape the complex influence of science and technology worldwide.

* **Corresponding Author:** Franklin Nnanna Ibe, frankibe89@gmail.com
Department of Chemistry, Nwafor Orizu College of Education Nsugbe, Anambra State, Nigeria
Address: No. 1 college road, Abata, Nsugbe 432108, Anambra, Nigeria

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Massive growth in science and technology is posing tremendous pressure on the science education system. The advancement of any nation's economic and social development depends to a large extent on the level of its scientific and technological knowledge (Nwuba & Osuafor, 2021). All advanced countries have a strong scientific education foundation. A close look at the developed countries of the 21st century reveals that, as in the case of science and technology, they transfer their practices in education (Okekeokosisi & Okigbo, 2021).

In Nigeria, the level of scientific development reflects our economic and social development. Okekeokosisi & Anaekwe (2024) opined that a well-developed and well-implemented science and technology education programme in a country will not only produce a knowledgeable and skilled technology workforce but also usher in sustainable socio-economic growth and political stability. Therefore, there is a need to improve and raise the standards of achievement, interest, and retention of our students in Chemistry education.

Chemistry is one of the fundamental sciences taught in secondary schools, encompassing the study of the properties, composition, and structures of matter, as well as the changes that matter undergoes and their implications for human welfare and society. It serves as the foundation for scientific and technological advancements, influencing nearly every aspect of daily life, from health and agriculture to food, shelter, clothing, and education (Brem et al., 2021). Given its pivotal role, the teaching and learning of Chemistry in schools deserve significant attention. Unfortunately, students' achievement in Chemistry, particularly in the Senior Secondary School Certificate Examination, has been disappointing. This is evident in the fluctuating results from the WAEC examinations over the years.

From the above statistical results on Chemistry achievement in WAEC Examinations (2019-2023), it was observed that the WAEC statistics for Chemistry students in these years have not shown a consistent upward trend. The WAEC Chief Examiners identified several critical weaknesses among students in their understanding of acids, bases, and acid-base reactions. These weaknesses highlight a pressing need for improved educational strategies in the subject. One of the most significant issues identified is the poor knowledge of acids, bases and acid-base reactions (Jiménez-Liso et al., 2020). Many students demonstrated a fundamental lack of understanding of key concepts, which adversely affected their overall performance. This deficiency is further compounded by students' inability to accurately report results from acid-base titration experiments, a vital skill in Chemistry that requires both practical ability and theoretical understanding. The consistent failure to write correct chemical equations for acid-base reactions has also been a significant concern, reflecting a more profound lack of understanding of essential chemical processes.

Additionally, students have struggled with calculations involving molar and mass concentrations, as well as with applications of the gas laws. These skills are critical for success in Chemistry, yet many students displayed significant difficulties in executing them effectively (Fletcher et al., 2017). Furthermore, communication skills have proven inadequate, with students often using trivial names rather than proper chemical formulae, which undermines their ability to articulate scientific ideas clearly and accurately. The inability to provide accurate graphical representations of concepts has also been noted, highlighting gaps in understanding the relationships between different chemical variables. Another recurring issue is students' failure to follow instructions during examinations, which prevents them from fully demonstrating their knowledge and skills. The cumulative effect of these weaknesses underscores the dire need for improvement in the teaching and learning of Chemistry, particularly in acids, bases, and acid-base reactions.

The Chemistry of acids, bases, and acid-base reactions is a fundamental area of study within the discipline of Chemistry, vital for understanding both theoretical concepts and practical applications. Acids are substances that can donate protons (H^+ ions) in solution, leading to distinct properties such as a sour taste and the ability to turn blue litmus paper red. Common examples include hydrochloric acid (HCl) and Tetraoxosulphate (vi) acid (H_2SO_4). Bases, conversely, are substances that can accept protons or release hydroxide ions (OH^-) in a solution. They are typically characterised by a bitter taste and a slippery feel, as seen in substances such as sodium hydroxide ($NaOH$) and ammonia (NH_3) (Manian et al., 2022).

The interaction between acids and bases underlies acid-base reactions, which are central to many chemical processes (Gacek & Berg, 2015). In a typical acid-base reaction, an acid reacts with a base to produce a salt and water, a process known as neutralisation. The underlying principles of acid-base Chemistry are governed by theories such as the Arrhenius, Bronsted-Lowry, and Lewis definitions, each providing a framework for understanding how these substances interact. The relevance of this knowledge extends far beyond the laboratory. In a secondary school context, understanding the Chemistry of acids, bases and acid-base reactions is critical for several reasons. It enhances academic achievement, interest and retention. WAEC Chief examiners' individual reports from 2019-2023 observed that Chemistry students experienced weakness mostly in these areas of Chemistry due to poor knowledge of the concepts, were unable to report results of acid-base titration experiments, were unable to make calculations on molar concentration and mass concentration, exhibited poor communication skills and used trivial names instead of formulae. The continued evidence of these concepts identified in WAEC Chief Examiners' Reports over several years led to the selection of these topics, which contributed to the overall poor academic retention in Chemistry (Chigbu et al., 2023).

Retention is the ability to store what has been learnt and recall it from memory. Kim et al (2013) averred that retention is the ability to retain and later remember information or knowledge gained when the need arises. The nature of the resources to be coded affects retention (Bouwmeester et al., 2019). Dos (2015) noted that retention is high when the degree of original information is high. In other words, any teaching method that leads to effective coding results in higher retention. In the context of this study, retention means knowledge retention. Knowledge retention involves capturing and storing knowledge for later use. Some students can retain information for a long time, while others do not. This is a function of the memory. A person's memory stores and retains information that is seen, heard, learned, or experienced.

Many studies have been conducted on retention. Woldemariam (2024) reported that failure to provide sufficient application to real-life activities and social use, and poor teaching techniques, are strong limiting factors to students' retention in Chemistry. In support of this, Ávalos & Valenzuela (2016) stated that retention depends on the teaching strategy adopted by the teacher. In the same vein, Fischer & Hänze (2019) argued for the adoption of instructional methods that promote students' involvement and activity in the teaching of secondary school Chemistry to enhance retention. The persistent challenges faced by students call for the adoption of effective instructional strategies that can enhance academic achievement, interest, and retention. Such strategies. Such strategies will help students not only achieve better in external examinations like WAEC but also develop a more robust understanding of Chemistry through appropriate instructional strategies in the teaching and learning of Chemistry.

Instructional strategy is a set of principles and methods used by teachers to enable student learning. These strategies are determined by both the subject matter to be taught and the learner's nature. For a particular instructional strategy to be appropriate and efficient, it must take into account the learner, the nature of the subject matter, and the learning it is intended to foster (Gorghiu et al., 2015). Chemistry as a science subject is activity-based. There are two types of instructional strategies: conventional and innovative (Ahmad et al., 2023). Conventional instructional strategy refers to instruction using chalk and a board for teachers and pen and paper for students. In a conventional instructional strategy, students are not engaged in critical thinking, leading to rote learning and limited knowledge transfer. In a conventional instructional strategy, students are very passive. Chemistry teachers often use conventional instructional strategies, including the lecture method, demonstrations, and direct instruction (Ibrahim et al., 2014). For this study, the lecture instructional strategy or method will be considered.

The lecture method (LM) of instruction is a teacher-centred, information-centred approach in which the teacher speaks, and students listen. Benefits of the lecture method (LM) include time-saving, scalability, every student gets the same thing, suitability for large-group learning, and the ability to provide additional content and a clear plan. Despite these benefits, the teaching method was found to stress the transmission of knowledge in a manner that emphasises memorisation; hence, it has been characterised by some educators as a poor method of teaching Chemistry and science subjects. (Zendler & Greiner, 2020). Another method of instruction is the use of innovative instructional strategies. Innovative instructional strategies, on the other hand, are new and creative ways of teaching. Innovative instructional strategies include cooperative learning, brainstorming, and think-pair-share (TPS), among others (Sivarajah et al., 2019). For this study, the think-pair-share instructional strategy is considered.

The Think-Pair-Share (TPS) instructional strategy is a cooperative strategy that encourages students to work together to solve problems and answer questions on an assigned topic. Think-pair-share, as the name indicates, involves students individually thinking about challenging academic tasks given by the teacher, then exchanging ideas with other students and sharing them with the larger class (Solheim et al., 2018). In the think-pair-share strategy, every student is an active learner and teacher. In think-pair-share, the teacher produces a chart of students' seating arrangement. Using the chart, students are paired in class to facilitate greater interaction. During pair interactions, students are expected to bring to the pair what they think is the solution to the problem, after the teacher gives them time to think before pairing (Lochhead, 2014).

The student pairs are to examine each other's solutions to the problem, criticise or add to them, or learn from them. The process of collaborative learning, in which students in pairs combine previously thought-out ideas to solve a problem, aligns with the principles of human capital development and organisational dynamics. Mbuba (2022) emphasises the importance of equipping individuals with cognitive and collaborative competencies to boost productivity. Similarly, Mbuba (2016) highlights how structured interaction and teamwork contribute to growth and resolution in organisations. When applied in the classroom, as in the Think-Pair-Share strategy, such collaboration fosters knowledge construction, reflective thinking, and practical communication skills, all of which are essential for both personal and organisational development. The teacher randomly assigns students from the chart to ensure that all students are involved and that the intelligent ones do not dominate the activities (Xia et al., 2022). After sharing, the teacher summarises the lesson in the order in which students are supposed to learn. In other words, think-pair-share takes place in three stages: individuals think silently about a question or task presented by the teacher; individuals pair up and exchange ideas; and pairs share their views with the whole class. These learning processes foster a better understanding among students. Some researchers believed that think-pair-share, as one of the innovative instructional strategies, could facilitate the learning and teaching of the Chemistry subject (Onu & Eze, 2020). Mundelsee & Jurkowski (2021) asserted that think-pair-share (TPS) could be a powerful means to boost the academic achievement of secondary school students in science subjects, including Chemistry. It is believed that students need to be appropriately guided through innovative teaching methods, such as the think-pair-share instructional strategy, to facilitate their understanding of complex Chemistry concepts, such as acids, bases, and acid-base reactions, as discussed in WAEC Chief Examiners' reports. Thus, this study investigates the effect of the think-pair-share instructional strategy on secondary school Chemistry students' achievement, interest, and retention, with gender as a moderator.

Gender is defined as the state of being male or female. Gender is an individual's biological sex and has become an important determinant in science and technology education. Some researchers have presented contradictory evidence on gender differences in students' academic achievement in science. Different instructional methods are either gender-sensitive or gender-biased. Kollmayer et al. (2018) identified sex-role stereotyping and a masculine image of science as the origin of the differences between male and female achievement in science education. Zhan et al. (2015) report that females performed better than male students when taught Mathematics using cooperative learning. Kebede et al. (2025) averred that think-pair-share, an effective teaching strategy, improves the achievement of male and female integrated science students, especially female students. These mixed findings warrant determining whether the think-pair-share instructional strategy will provide an inclusive method to facilitate male and female Chemistry students' achievement, interest, and retention in acid-base reactions. These areas are considered very important in Chemistry teaching and learning and feature prominently in WAEC examination questions. It is against this backdrop that the researcher investigates the use of an innovative teaching strategy, the think-pair-share instructional strategy, on students' retention in Chemistry in senior secondary schools in Anambra State.

This study aims to examine the effect of the think-pair-share instructional strategy on secondary school students' retention in Chemistry. Specifically, the study aims to determine two key aspects: first, the mean retention scores of students taught Chemistry using the think-pair-share strategy compared to those taught through the lecture method. Second, the study will investigate the mean retention scores of male and female students who were taught Chemistry using the think-pair-share instructional strategy. By addressing these points, the study seeks to provide valuable insights into the effectiveness of think-pair-share in enhancing student retention in Chemistry.

2. METHOD

2.1 Research Design

The study employed a quasi-experimental design, specifically the pretest-posttest non-equivalent control group design. The research was conducted in the Awka Education Zone of Anambra State, which encompasses forty-nine government-owned co-educational secondary schools. The study aimed to investigate the impact of the think-pair-share instructional strategy on students' retention in Chemistry.

2.2 Participants

The study population consisted of 5,714 senior secondary one (SS1) Chemistry students (3,173 females and 2,541 males) in the Awka Education Zone. A total of 192 senior secondary one Chemistry students were selected as the study's sample. Stratified and simple random sampling techniques were used to select the schools and students for participation. Four co-educational schools were selected, with two assigned to the experimental group and two to the control group. The experimental group included 48 male and 54 female students, while the control group comprised 49 male and 41 female students.

2.3 Data Collection

The instrument used for data collection was the Chemistry Retention Test (CRT), which consisted of 50 multiple-choice questions covering the concepts of acids, bases, and acid-base reactions. The questions were designed based on a table of specifications representing different levels of knowledge. Each correct response earned 2 marks, yielding a total of 100. Experts in the Departments of Science Education and Educational Foundations validated the instrument. Reliability was established using the Kuder-Richardson 20 (KR-20) formula, yielding a reliability coefficient of 0.81 after administration to a sample of 30 SS1 Chemistry students outside the study area.

2.4 Data Analysis

The collected data were analysed using mean and standard deviation to address the research questions. To test the hypotheses, an analysis of covariance (ANCOVA) was conducted. The decision rule followed was that if the p-value were less than or equal to 0.05, the null hypothesis would be rejected. If the p-value were greater than 0.05, the null hypotheses would not be rejected.

The experimental procedure included two phases: training of research assistants and the treatment phase. The training phase involved the research assistants, who were Chemistry teachers from the sampled schools. The training covered the think-pair-share strategy for the experimental group and the lecture method for the control group. The treatment phase lasted six weeks, with four weeks allocated for pretest and posttest administration and two weeks for the retention test.

In the treatment phase, the pretest was administered first, followed by student orientation to the think-pair-share strategy. The teacher modelled selecting pair partners and explained that students would work in pairs for the entire treatment period. Weekly lessons on the Chemistry concepts were conducted, with students challenged to answer questions and present their findings. Random participation was ensured by randomly selecting students to answer questions during each lesson. After the treatment, the same instruments were used for the posttest and a retention test, administered two weeks later.

3. RESULT AND DISCUSSION

3.1 Result

a) Research Question 1

What is the difference in the mean retention scores of students taught Chemistry with the think-pair-share instructional strategy and those taught using the lecture method?

Table 1: Mean and Standard Deviation of Retention Scores of Students Taught Chemistry with TPS and those Taught Using LM

Group	N	Post-test		Retention		Mean Loss	Mean Loss Difference
		Mean	SD	Mean	SD		
TPS	102	73.55	4.24	69.18	5.38	4.37	5.52
LM	90	63.11	5.10	53.22	5.88	9.89	

The results in Table 1 showed that the post-test and retention test mean scores of students taught Chemistry with TPS were 73.55 and 69.18, respectively, while the standard deviation scores were 4.24 and 5.38, respectively. On the other hand, the post-test and retention test scores for those taught with LM were 63.11 and 53.22, respectively, with standard deviation scores of 5.10 and 5.88, respectively. The post-test standard deviation score for the experimental group (TPS) was lower than that of the retention test. This suggested less variability in the students' post-test scores than in their retention test scores in the TPS group. Hence, more scores were near the mean in the retention test than in the post-test for Chemistry students in the TPS group. Moreover, the post-test standard deviation score in the control group (LM) was lower than that of the retention test. This suggested less variability in the students' post-test scores than in their retention test scores in the LM group. So, more of the scores were near the mean in the retention test than in the post-test of students in the LM group.

The mean loss scores for Chemistry students taught with TPS were 4.37, while those of LM were 9.89. This represented a mean loss difference of 5.52 in favour of students taught Chemistry with TPS. This implied that students taught with TPS had better academic retention in Chemistry than those taught with LM.

b) Research Question 2

What is the difference in the mean retention scores of male and female students taught Chemistry with the think-pair-share instructional strategy?

Table 2. Mean and Standard Deviation of Retention Scores of Male and Female Students Taught Chemistry with TPS

Group	N	Post-test		Retention		Mean Loss	Mean Loss Difference
		Mean	SD	Mean	SD		
Male	48	73.92	4.19	69.42	5.23	4.50	0.24
Female	54	73.22	4.30	68.96	5.55	4.26	

The results in Table 2 showed that the posttest and retention test mean scores for male students taught Chemistry with TPS were 73.92 and 69.42, respectively, with standard deviation scores of 4.19 and 5.23, respectively. On the other hand, the posttest and retention test mean scores of female students taught Chemistry with TPS were 73.22 and 68.96, respectively, while the standard deviation scores were 4.30 and 5.55, respectively. The posttest standard deviation score for male students taught Chemistry using TPS was lower than that of the retention test. This suggested less variability in the posttest scores of the students than in the retention scores of male Chemistry students. Hence, more scores were near the mean in the retention test than in the posttest among male students using TPS. Moreover, the standard deviation score for the female students taught Chemistry using TPS was lower than that for the retention test. This suggested less variability in the posttest scores of the female students than in the retention scores. So, more scores were near the mean in the retention test than in the posttest among female students using TPS.

The mean loss retention score for male Chemistry students taught with TPS was 4.50, while that of their female counterparts was 4.26. This represented a slight mean loss difference of 0.24 in favour of female students taught Chemistry using TPS. This implied that female students had a slightly higher mean retention score than their male counterparts when taught with TPS.

c) Hypothesis 1

There is no significant difference in the mean retention scores of students taught Chemistry using the think-pair-share instructional strategy and those taught using the lecture method.

Table 3. Analysis of Covariance (ANCOVA) of Chemistry Students' Mean Retention Scores between Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	15715.282[a]	4	3928.820	299.238	0.000	
Intercept	4.477	1	4.477	0.341	0.560	
Posttest	3537.004	1	3537.004	269.396	0.000	
Groups	836.443	1	836.443	63.708	0.000	S
Gender	8.713	1	8.713	0.664	0.416	NS
Groups * Gender	18.114	1	18.114	1.380	0.242	NS
Error	2455.197	187	13.129			
Total	749044.000	192				
Corrected Total	18170.479	191				

S= Significant, NS = Not Significant

The result in Table 3 showed that there was a significant difference in the mean retention scores of students taught Chemistry with TPS and those taught using LM, F (1, 187) = 63.708, p = 0.000. Since the obtained p-value was less than the stipulated 0.05 level of significance, the null hypothesis that there was no significant difference in the mean retention scores of students taught Chemistry with the think-pair-share instructional strategy and those taught with the lecture method was rejected. This implied that the mean retention score for students taught with TPS was significantly higher than that for students taught with LM.

d) Hypothesis 2

There is no significant difference in the mean retention scores of male and female students taught Chemistry with the think-pair-share instructional strategy.

Table 4. Analysis of Covariance (ANCOVA) of Mean Retention Scores of Male and Female Students Taught Chemistry with TPS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	2071.414[a]	2	1035.707	120.430	0.000	
Intercept	30.385	1	30.385	3.533	0.063	
Posttest	2066.184	1	2066.184	240.251	0.000	
Gender	2.118	1	2.118	0.246	0.621	NS
Error	851.409	99	8.600			
Total	491032.000	102				
Corrected Total	2922.824	101				

NS = Not Significant

The result in Table 4 showed that there was no significant difference in the mean retention scores of male and female students taught Chemistry using TPS, F (1, 99) = 0.246, p = 0.621. Since the obtained p-value was higher than the stipulated 0.05 level of significance, the null hypothesis, which stated that there was no significant difference in the mean retention scores of male and female students taught Chemistry with the think-pair-share instructional strategy, was upheld. This implied that TPS use significantly improved the mean retention scores of both male and female students in Chemistry.

3.2. Discussion

The study found that students taught Chemistry using the TPS instructional strategy retained more than those taught Chemistry using the lecture method. This aligned with Borokhovski et al. (2016), who reported that using an instructional strategy enabled both high- and low-ability students to retain concepts taught in the Chemistry class. In agreement, Warfa (2016) reported that students taught Chemistry using the Cooperative instructional method retained significantly more than those taught the same material using the conventional lecture method. The revelation of this study that students taught Chemistry using the TPS instructional strategy retained more than those taught Chemistry using the lecture method could be that TPS enhanced retention by tailoring instruction to each learner's unique needs.

The findings further showed that the TPS instructional strategy had a significant effect on students' retention in Chemistry when compared with those taught with LM. These findings were not far from the assertion of Chigbu et al. (2023), who found that the mean retention scores of students taught Chemistry using an improvised instructional method were significantly higher than those of students taught using a conventional method. The significant improvement in retention ability of students exposed to the TPS instructional strategy, as revealed in this study, could be linked to the fact that the TPS instructional strategy recognized the unique nature of Chemistry and the learner's individuality. Thus, encouraged active participation, creative thinking, and students' problem-solving ability, leading to improved student retention. Additionally, the efficacy of the TPS instructional strategy in enhancing students' retention compared to the lecture method may be attributed to students' active participation at every stage of the instructional model.

Furthermore, it may be attributed to students' encouragement to work together as a team to attain group goals, the autonomous discovery of knowledge, and taking control of their studies with active teacher facilitation. Hong & Yu (2017) affirmed that the difference in retention between the experimental and control groups arose from the fact that the TPS instructional strategy encouraged students to collaborate and share ideas more frequently about a particular subject. Additionally, Chiu & Mok (2017) reported that the TPS instructional strategy allowed the development of retention ability among Mathematics students. Attributed this increase to the interaction and motivational effects of the TPS instructional strategy. This study has contributed to the body of knowledge by observing a significant difference in the mean retention scores of students taught Chemistry using the TPS instructional strategy and those taught using the lecture method, in favour of those taught using the TPS instructional strategy.

The study found that female students retained more than male students taught Chemistry using the TPS instructional strategy. This aligned with Putz et al. (2020), who indicated that female students retained more than their male counterparts in the use of instructional strategies. This also aligned with Munir et al. (2018), who reported that female students retained the cooperative learning strategy more than their male counterparts. The reason female students retained more than male students who were taught Chemistry using the TPS instructional strategy in the study could be that female students benefited more from collaborative environments that promoted engagement and self-esteem. Alternatively, cooperative learning often fosters a supportive atmosphere that has enhanced female students' confidence. A cooperative learning strategy may address specific learning needs or preferences among female students, thereby improving retention of the secondary school Chemistry concept used in this study.

The result also showed that there was no significant difference in the mean retention scores of male and female students taught Chemistry using the TPS instructional strategy. This was in line with Abimbade et al. (2023), who observed no significant difference between male and female students taught Biology with the think-pair-share and Brainstorming strategy. The finding was also consistent with Oladejo et al. (2023), who reported that gender differences did not exist in Chemistry retention among secondary school students. The lack of a significant difference in mean retention scores between male and female students taught Chemistry using the TPS instructional strategy may indicate that the learning strategy was equally effective for diverse learners. It indicated that the learning strategies utilized catered to various learning styles or that the instructional quality was consistent across both groups. Other factors, such as motivation, prior knowledge, teaching experience, and classroom environment, also play a role in achieving similar retention outcomes. This result indicated that the use of the TPS instructional strategy enabled both male and female students to gain, retain, and be highly motivated, and offered them the opportunity to develop their creative abilities through interaction with their pairs, irrespective of gender, and thus enabled them to recall what they learnt. By virtue of this finding, this study has joined the body of knowledge that has found no significant difference in the mean retention scores of male and female students taught Chemistry using the TPS instructional strategy.

4. IMPLICATIONS AND CONTRIBUTIONS

4.1 Reseach Implication

The findings of this study have important implications for science education, particularly Chemistry instruction at the secondary school level. The significant improvement in students' academic retention through the use of Think-Pair-Share (TPS) suggests that student-centred, interactive teaching strategies enhance long-term knowledge retention more effectively than traditional lecture methods. This calls for curriculum developers and policymakers to integrate TPS into instructional guidelines. Additionally, teacher education programs should emphasise TPS and similar collaborative learning approaches during training.

4.2 Reseach Contribution

This study contributes to the existing body of knowledge in science education by providing empirical evidence that the Think-Pair-Share instructional strategy significantly enhances students' academic retention in Chemistry regardless of gender. It strengthens the theoretical foundation supporting cooperative learning as a practical pedagogical approach in secondary education. Additionally, the study offers practical contributions by serving as a reference for educators, school administrators, and policymakers seeking evidence-based strategies to improve learning outcomes in Chemistry. The findings also provide a basis for future research on active learning strategies and their impact on retention and achievement in other science subjects and educational contexts.

5. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

5.1 Reseach Limitations

Despite its contributions, this study has some limitations that should be acknowledged. First, the study used a quasi-experimental design. It involved a relatively small sample from a single state, which may limit the generalizability of the findings to other regions or educational contexts. Second, the focus was restricted to selected Chemistry topics (acids, bases, and acid–base reactions), and the retention test was administered within a limited time frame; therefore, the long-term effects of the Think-Pair-Share (TPS) strategy on retention over extended periods were not examined. Additionally, variables such as students' prior knowledge, teachers' level of proficiency in using TPS, and classroom environment were not fully controlled.

5.2 Recommendations for Future Research Directions

Future research should consider using larger, more diverse samples across multiple states or countries to enhance the external validity of the findings. Longitudinal studies are recommended to examine the sustained impact of TPS on students' academic retention over more extended periods. Further studies could also explore the effecttiveness of TPS across a broader range of Chemistry topics and other science subjects and investigate the influence of moderating variables, such as students' learning styles, motivation, and teachers' instructional competence.

6. CONCLUSION

The findings confirm that the think–pair–share instructional strategy is a practical approach for teaching and learning Chemistry concepts, particularly in strengthening students' academic retention. By structuring lessons around individual thinking, paired discussion, and shared reflection, the strategy deepens conceptual processing and helps students internalise key ideas. This active learning sequence not only improves retention but also increases engagement, making Chemistry lessons more meaningful and accessible to learners.

The study also highlights the social and motivational value of think–pair–share in the classroom. Increased student-to-student interaction promotes accountability, confidence, and collaborative problem-solving, encouraging learners to take greater responsibility for their own understanding. Such participation shifts the classroom dynamic from teacher-centred delivery to learner-centred exploration, where misconceptions can be addressed through dialogue and peer support, reinforcing both cognitive and interpersonal dimensions of learning.

Taken together, these outcomes indicate that consistent use of think–pair–share can serve as a practical framework for creating student-centred Chemistry instruction. Teachers who intentionally integrate this strategy foster environments that emphasise engagement, reflection, and cooperation, all of which support sustained retention and academic growth. Continued adoption of interactive instructional practices is therefore recommended to promote meaningful learning experiences and long-term improvement in Chemistry education.

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Author Contribution Statement

The author declares that the entire research and writing process for this article was conducted independently. The author assumes full responsibility for all data associated with this research. No other individual contributed as a co-author or made any significant contribution to the content of this work.

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Conflict of Interest Statement

The author declares no conflicts of interest or potential conflicts related to the research, writing, and/or publication of this article.

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