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THE EFFECTIVENESS OF THE THINK PAIR SQUARE (TPSq) COOPERATIVE LEARNING MODEL ASSISTED BY STICK MEDIA ON STUDENT LEARNING OUTCOMES IN CHEMICAL COMPOUND NOMENCLATURE

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Abstract

Low student learning outcomes are often caused by limited student participation and the use of teacher-centered learning approaches. This study aims to determine the effectiveness of the Think Pair Square (TPSq) cooperative learning model assisted by stick media in improving student learning outcomes, particularly in the topic of chemical compound nomenclature. The research used a pre-experimental one-group pretest-posttest design with participants from class X-10 students at a senior high school (N=32). Learning outcomes were measured using tests given before and after the implementation of the model. Data were analyzed using a non-parametric Wilcoxon test. The results indicated a significant improvement in student learning outcomes, with an N-Gain score of 0.71 (high category) and an effect size of 3.85 (very strong category). The TPSq model, supported by stick media, encouraged students to think, discuss, and share ideas actively, leading to a deeper understanding of the material. In conclusion, the stick media-assisted TPSq learning model is effective in enhancing student learning outcomes in chemical compound nomenclature.

***Keywords**: learning effectiveness; learning outcomes; think pair square; stick media; chemical compound*

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INTRODUCTION

Education plays a fundamental role in enhancing the quality of human resources by facilitating the development of various life competencies that directly influence both individual and societal progress. The design of an effective learning process necessitates not only adequate facilities but also the presence of competent educators. Nevertheless, in practical implementation, instructional activities often face diverse challenges, necessitating adaptive strategies that align with contextual realities and educational objectives to optimize learning outcomes.

A critical factor in achieving effective learning is the selection of an appropriate instructional model. Teachers are increasingly expected to implement strategies that promote student engagement and improve academic performance [1, 2]. Among various pedagogical approaches, cooperative learning is widely acknowledged for its capacity to encourage active participation, peer-to-peer interaction, and deeper conceptual understanding.

One of the cooperative learning models that has gained attention is the Think-Pair-Square (TPSq) model, an extension of the Think-Pair-Share (TPS) model, which integrates collaborative work within small groups beyond initial pair interactions. Empirical findings indicate that TPSq enhances critical thinking, communication, and collaboration skills among students [3, 4]. However, existing studies have also identified notable limitations, including disproportionate participation during group discussions and reduced engagement among less confident students during class-wide presentations [5].

While the theoretical strengths of the TPSq model are well-documented, empirical research tends to emphasize cognitive outcomes, with limited focus on mechanisms that support equitable student participation and foster intrinsic motivation. For example, found that although TPSq contributed to improved conceptual understanding, passive students remained largely uninvolved in whole-class discussions. In a similar vein, noted that in the absence of structured facilitation techniques, more vocal students tend to dominate the discourse [7]. These challenges underscore the need to enrich the TPSq model with practical tools that facilitate inclusive engagement and balanced participation.

One such facilitative tool is the use of stick-based learning media, adapted from the traditional "talking stick" method. This strategy involves using physical markers (sticks) to visually and procedurally manage turn-taking, thereby ensuring equitable speaking opportunities through random assignment. Previous studies have shown that stick media can enhance students' confidence, accountability, and willingness to participate actively [6]. Furthermore, this method is consistent with the principles of 21st-century education, which emphasize collaborative learning, communication, and active student involvement [7]. Despite its promising attributes, there remains a notable research gap regarding the integration of stick media into structured cooperative learning frameworks such as TPSq. Most studies to date have examined either cooperative learning or stick media in isolation, without assessing their combined influence on learning effectiveness.

This research is situated within the context of chemical education, specifically the topic of chemical compound nomenclature a subject known for its abstract nature, which demands both memorization and conceptual understanding in the absence of quantitative calculations or laboratory-based activities. Such characteristics often lead to reduced student engagement, particularly when instruction is delivered through teacher-centered methods [8, 9], ultimately resulting in suboptimal academic performance in this domain [10].

Although the TPSq model has demonstrated pedagogical potential in promoting collaborative learning, its integration with stick-based media remains largely unexplored, particularly in the context of abstract subject matter such as chemical compound nomenclature. This study aims to address that gap by investigating the combined implementation of the TPSq model and stick media as a strategy to foster a more interactive and equitable classroom environment. The integration is expected to enhance student engagement, support conceptual understanding, and offer a practical, innovative instructional approach for educators. Specifically, the objective of this research is to evaluate the effectiveness of the Think-Pair-Square cooperative learning model assisted by stick media in improving student learning outcomes in the topic of chemical compound nomenclature. The findings are anticipated to contribute meaningfully to the development of more inclusive and engaging instructional practices in science education.

METHOD

This research employed a pre-experimental design using the One-Group Pretest-Posttest Design model. The study was conducted at a public high school in Samarinda, with the sample consisting of one class Grade X-10 comprising 32 students. The sample was selected through purposive sampling based on specific criteria, including the class's average academic performance being representative of the overall tenth-grade population and the availability of the class for treatment during the research period. This approach ensured that the selected sample adequately represented the characteristics of the target population.

The independent variable in this study was the stick-assisted TPSq-type cooperative learning model, while the dependent variable was student learning outcomes. Data were collected through both test and non-test instruments. The test instruments included a pretest and posttest to measure student learning outcomes. Non-test instruments included observations, student response questionnaires, and documentation.

Two methods of data analysis were used: descriptive analysis and inferential statistical analysis. The inferential analysis began with a normality test to determine whether the data distribution met the assumptions for parametric testing. Since the data were found not to be normally distributed, a non-parametric statistical test, specifically the Wilcoxon signed-rank test, was employed. The Wilcoxon test was chosen because it is appropriate for analyzing paired data from non-normally distributed populations, making it suitable for comparing pretest and posttest scores in this study.

A third analysis involved calculating the normalized gain (N-gain), using the Gain Score formula and criteria presented in Table 1

$$N - Gain\ (g) = \frac{(Post\ test\ Score) - (Pretest\ Score)}{(Max.Score) - (Pretest\ Score)}$$

Table 1. *Gain Score* Criteria [11]

Gain score average	Category
(g) ≥ 0.7	High
0.3 ≤ (g) < 0.7	Medium
(g) > 0.3	Low

The N-gain value is derived from the comparison between pre-test and post-test scores. If the N-gain value indicates an improvement in student learning outcomes, the analysis is then continued by calculating the effect size for the one group. This calculation is performed using Microsoft Excel, based on the following formula:

$$\textit{Effect size} = \frac{\text{(Posttest average-Pretest average)}}{\text{Pretest Standard Deviation}}$$

The interpretation of effect size values can be referred to Table 2, which provides criteria for determining effect size.

Table 2. *Effect Size* Interpretation [11]

Limitation	Category
d ≤ 0.20	Weak effect
0.20 < d ≤ 0.50	Moderate effect
0.50 < d ≤ 1.00	Strong effect
d > 1.00	Very strong effect

RESULTS AND DISCUSSION

Implementation of Stick-Assisted TPSq Learning Model

The implementation of learning refers to the extent to which teachers successfully deliver the instructional treatment in the classroom, ensuring that the teaching process aligns with the intended objectives and procedures. Observations were conducted by an observer during the teaching and learning activities to evaluate both teacher and student engagement throughout the implementation of the stick-assisted TPSq-type cooperative learning model. The observation results averaged from the first and second meetings are presented in Table 3.

Table 3. Observation of Teacher and Student Activities

Activity Observation	Percentage (%)	Category
Teacher Activities	94.00	Very Good
Student Activities	87.50	Good

An average teacher activity score of 94%, categorized as very good, indicates that the teacher effectively fulfilled their role in designing, facilitating, and guiding the learning process. Within the context of the stick-assisted TPSq model, this high level of teacher activity reflects active involvement in managing the flow of discussions, stimulating student thinking, and ensuring that every student had the opportunity to participate. A "good" level of teacher activity in this model means the teacher acts not only as a knowledge transmitter but also as a facilitator who actively promotes equitable student participation. Teachers who are highly engaged in cooperative learning settings play a key role in fostering a classroom environment that enhances students' cognitive engagement [12, 13].

Meanwhile, a student activity score of 87.5%, which falls into the good category, demonstrates that students were not merely passive listeners, but actively engaged in thinking, discussing, and expressing their ideas. In the stick-assisted TPSq learning model, students take turns speaking and sharing their understanding, which minimizes teacher-centered dominance and promotes balanced participation. This level of student activity reflects meaningful involvement in the learning process such as asking and answering questions, engaging in discussions, and responding to peers' ideas. Such active participation in small groups supports better retention of information and deeper understanding of concepts through social interaction and cognitive elaboration. Therefore, high levels of both teacher and student activity serve as strong indicators of learning quality, which in turn contributes to improved learning outcomes [14, 15].

Recent studies have consistently highlighted the benefits of cooperative learning strategies, such as Think-Pair-Share (TPS), in promoting deeper learning and engagement. For example, a meta-analysis by Johnson and Johnson (2022) [16] revealed that cooperative learning significantly enhances students' academic achievement and social skills by encouraging active collaboration and peer feedback. Similarly, a study by Warsah et al (2021) [17] demonstrated that small-group discussions stimulate critical thinking and improve information retention through cognitive elaboration and social interaction.

The stick-assisted variation of the TPS model adds an innovative element by encouraging structured turn-taking. This ensures that all students contribute, addressing a common issue in group learning where some participants may dominate discussions. In addition to enhancing individual learning, such active participation in small groups contributes to better classroom dynamics. When students feel that their voices are heard, it builds a sense of community and mutual respect, further motivating them to engage. This synergy between cognitive and social dimensions of learning supports the argument that high levels of teacher and student activity are not only indicators of quality learning but also crucial drivers of improved outcomes.

The effect of Stick-Assisted TPSq Learning Model on The Students Learning Outcomes

The learning outcomes of Grade X students were assessed through pretest and posttest scores. The comparison of these results illustrates the effectiveness of the stick-assisted TPSq-type cooperative learning model in improving student performance. The data are presented in Figure 1.

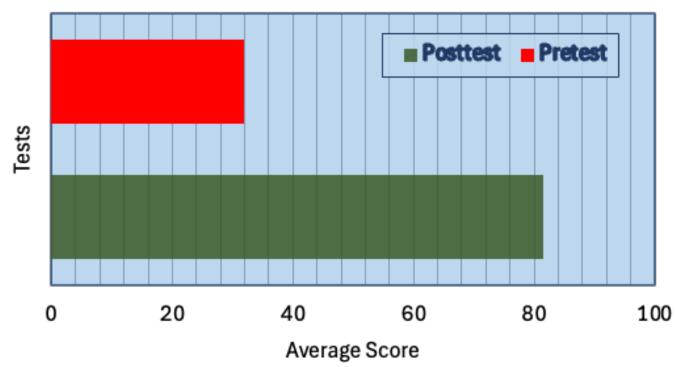

Figure 1. Average Pretest and Posttest Scores

Based on the data obtained, the learning outcomes of Grade X-10 chemistry students have shown significant improvement. As seen in Figure 1, the average score, initially 31.83, increased to 81.42 following the implementation of the stick-assisted TPSq learning model. In addition to this increase, the average score also exceeded the minimum completeness criteria (MCC) of 75.

Among all students, 98% were able to achieve or surpass the MCC after the learning intervention. This result demonstrates that most students not only improved their understanding of the material, but were also able to effectively demonstrate mastery of the chemical concepts targeted in the learning process, particularly in the area of compound nomenclature. This achievement further confirms the effectiveness of the stick-assisted TPSq model in enhancing learning outcomes uniformly across the classroom.

Following the pretest and posttest results, a normality test was conducted to determine whether the pretest and posttest scores were normally distributed. The Shapiro-Wilk test was used for this purpose, and the results are presented in Table 5.

Table 5. Normality Test

Class	Data	Sig.	Description
X-10	Pre-test	0.039	Not Normally Distributed
	Post-test	0.001	Not Normally Distributed

In Table 5, the results show that the average scores of the pretest and posttest are not normally distributed, as indicated by a significance value of less than 0.05. As a result, a non-parametric test (the Wilcoxon test) was conducted to determine whether there was a significant difference between the pretest and posttest scores.

Table 6. Wilcoxon Test Results

Parameter	Value
Wilcoxon W	532.500
Z	-6.866
Asym. Sig. (2-*Tailed*)	0.000

In Table 6, the values in the sig (2-tailed) column show a value of 0.000, which is less than 0.05. This indicates that there is a statistically significant difference between the pretest and posttest scores. Specifically, the results demonstrate an increase in student learning outcomes after the application of the stick-assisted TPSq learning model in chemistry lessons. These findings suggest that the implementation of this learning model has had a positive impact on student understanding. Furthermore, the improvement in learning outcomes reflects the success of the teaching strategies, which foster greater student engagement through discussion and group interaction.

Effectiveness of Stick-Assisted TPSq in Improving Student Learning Outcomes

The effectiveness of a learning process can be assessed based on three main indicators: the implementation of the learning activities, student engagement, and the overall classroom completion rate of learning outcomes [18]. Based on the data presented, the use of the stick-assisted TPSq cooperative learning model in chemistry instruction successfully meets all three indicators. The learning process was executed effectively, students were actively engaged throughout the lesson, and the classroom completion rate for learning outcomes was categorized as complete. Therefore, the application of this model not only enhances academic achievement but also fosters a dynamic and collaborative learning environment.

A learning process is considered effective if at least 85% of students achieve the Minimum Completeness Criteria (MCC) [19]. In this study, 98% of students met the MCC for the topic of chemical compound nomenclature. Additionally, the N-gain score of 0.71 falls into the high category, and the effect size of 3.85 indicates a very strong effect. These findings are consistent with previous research showing that cooperative learning can enhance academic performance and social skills. Hasanah stated that group work improves achievement, motivation, and social interaction [20]. Similarly, Nurfaddilah (2025) emphasized that the success of cooperative learning depends on positive interdependence and individual accountability within the group [21].

The main contribution of this study to the understanding of cooperative learning lies in the development and implementation of a new variant of the Think Pair Share model, namely Think Pair Square (TPSq), which has not been widely explored in previous literature. This model combines pair discussions followed by small group discussions of four students, supported by the use of stick media to ensure equal participation among students. This approach has proven effective in increasing student engagement by encouraging them to actively seek information and ask questions to peers or the teacher during discussions, thereby facilitating better understanding of the material. The interactions within these small groups also allow students to construct knowledge socially, complement each other's understanding, and reinforce concepts through peer explanation and elaboration [22].

Effective learning often takes place within the zone of proximal development, where students learn with the guidance of more knowledgeable peers or mentors [23]. In this context, group discussions in the TPSq model not only enhance cognitive understanding but also help develop communication and collaboration skills among students. Furthermore, active participation in these discussions has been shown to improve learning outcomes, as students gain a deeper understanding of the material through shared concepts and collective elaboration [24].

The use of stick-assisted media in the TPSq model plays a key role in promoting more interactive and student-centered learning. This model allows students to think independently in pairs, followed by group discussions, all facilitated by the stick strategy, which ensures that every student has an equal opportunity to speak. This approach is crucial for enhancing students' confidence, communication skills, and critical thinking abilities.

The strengths of this study include the use of a pre-experimental design with a pretest-posttest approach, which allows for quantitative analysis of changes in learning outcomes. Moreover, the measurement of effectiveness goes beyond test scores, also considering student activity and the overall implementation of the learning process, providing a comprehensive view of the model's impact. This research is practically relevant, as it was conducted in a school setting with teaching materials that align with the curriculum, making the findings applicable to similar learning practices in other classrooms.

CONCLUSION

Based on the research conducted, the implementation of the Think Pair Square (TPSq) cooperative learning model assisted by stick media has proven effective in enhancing student's learning outcomes on the topic of chemical compound nomenclature. This model promotes active participation, collaboration, and deeper conceptual understanding, thereby creating a more interactive and meaningful learning environment. The findings suggest that the TPSq model holds significant potential for broader application in chemistry education. Future research is recommended to examine its effectiveness on other chemistry topics, such as chemical bonding or reaction rates, as well as at different grade levels, to assess its broader applicability. Continued use of the TPSq model in classroom practice is also believed to support the development of student's critical thinking and collaborative skills, ultimately contributing to the overall improvement of science education quality.

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