

## **ENHANCED CONCEPTUAL UNDERSTANDING OF ELEMENTS AND COMPOUNDS THROUGH THE STAD LEARNING MODEL ASSISTED BY MOCHECLAY MEDIA**

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### *Article history:*

*Submitted: June 11<sup>th</sup>, 2025; Revised: July 14<sup>th</sup>, 2025; Accepted: Aug. 16<sup>th</sup>, 2025; Published: Jan. 18<sup>th</sup>, 2026*

### **ABSTRACT**

This study aimed to investigate the influence of the Student Teams Achievement Division (STAD) cooperative learning model supported by Mocheclay media on students' conceptual understanding in science. A quasi-experimental method was employed, utilizing a non-equivalent group design. Participants were selected through purposive sampling, with class VIII F (30 students) assigned as the experimental group taught using the STAD model assisted by Mocheclay, and class VIII H (30 students) as the control group taught through direct instruction. The calculated effect size was 1.23, indicating a strong influence of the STAD model supported by Mocheclay media on students' scientific conceptual understanding. The experimental group's normalized gain score reached 64%, whereas the control group achieved only 33%. Independent sample t-test results revealed a significant difference in conceptual understanding between students exposed to the STAD-Mocheclay approach and those taught with direct instruction.

**Keywords:** conceptual understanding; elements and compounds; STAD learning model; mocheclay media

### **INTRODUCTION**

Conceptual understanding serves as a fundamental foundation in science education, particularly in achieving the objectives of the science curriculum that emphasize critical thinking and scientific reasoning skills. Conceptual understanding involves students' ability to connect facts, principles, and procedures into a coherent and meaningful knowledge structure (Venkadasalam *et al.*, 2024). However, results from the Programme for International Student Assessment (PISA) indicate that most Indonesian students have not yet reached a level that reflects adequate conceptual understanding in science, as they still struggle to apply scientific knowledge in both simple and complex contexts (OECD, 2023). Students often face difficulties in classifying, summarizing,

and explaining the interconnections between scientific concepts and their applications in daily life (Ainul *et al.*, 2025; Janah & Hidayati, 2025).

Low interest and motivation among students pose significant challenges for teachers in the learning process. Therefore, teacher readiness and creativity in implementing engaging instructional strategies are crucial for enhancing student motivation (Simatupang, 2024). Current science instruction often fails to encourage students to think critically, contextually, and conceptually about the topics discussed. As a result, students are less motivated to participate actively and construct their own understanding during the learning process (Hakim, 2020).

Classroom observations in Class VIII F at State Junior High School 8 Yogyakarta revealed that students experienced difficulties in grasping abstract science concepts, such as the topic of concave and convex mirrors. They struggled to trace the direction of light rays and understand the image formation process, which requires high-level spatial visualization. Although direct instruction and PowerPoint media had been used, students' understanding remained limited due to the one-way nature of the learning strategy, which lacked active student engagement. Similar difficulties were also evident in other abstract topics such as elements and compounds (Yuningsih *et al.*, 2023). Students often forgot the names and structures of elemental and compound molecules, even when digital media like PowerPoint was utilized. These findings indicate that the instructional strategies employed were still insufficient in fostering students' conceptual understanding (Munika & Kurniati, 2021; Hulu & Siswati, 2024).

This problem highlights the need for innovative learning strategies that not only deliver content but also engage students actively in constructing their understanding. One relevant approach is the Student Teams Achievement Division (STAD), a cooperative learning model that emphasizes collaboration within heterogeneous groups to enhance understanding and achieve shared learning goals (Slavin, 1995). This model has been

## **METHOD**

This study employed a quantitative approach using a quasi-experimental method with a non-equivalent group design (Creswell, 2014). The research population consisted of eighth-grade students at SMPN Yogyakarta. The sample was selected using

shown to improve social interaction, learning responsibility, and students' conceptual understanding (Fanani, Ratnawati, & Inayah, 2022).

To make learning more meaningful, STAD can be integrated with concrete media such as Molymod or its modified version known as Mocheclay (Molymod Chemistry Clay). This three-dimensional medium enables students to physically construct visual representations of molecules of elements and compounds, helping them concretely visualize abstract concepts (Darnisyah *et al.*, 2023). The use of media such as Molymod has been found to enhance learning outcomes (Juita, 2023; Munika & Kurniati, 2021; Purwaningsih, 2022).

However, previous studies on STAD and Molymod have mostly focused on senior high school and vocational education levels. There is a lack of research on the integration of Mocheclay media in the STAD cooperative learning model at the junior high school level. Based on this background, the present study was conducted to examine the effect of the STAD model assisted by Mocheclay media on students' conceptual understanding of elements and compounds. The main focus of this research was to measure how effectively this model and media help students understand the structure of elements, compound formation, and molecular shapes through a visual and collaborative approach.

purposive sampling. Class VIII F, comprising 30 students, was assigned as the experimental group and received instruction using the STAD model assisted by Mocheclay media. Class VIII H, also consisting of 30 students, served as the

control group and received direct instruction. The research design is presented in Table 1.

**Table 1. Research Design**

Group	Pretest	Treatment	Posttest
<b>Experimental</b>	O1	X	O2
<b>Control</b>	O3	-	O4

**Description:**

- O1: Pretest in the experimental group
- O2: Posttest in the experimental group
- O3: Pretest in the control group
- O4: Posttest in the control group
- X: Treatment using the STAD model assisted by Mocheclay media

Students' conceptual understanding of science in both groups was assessed using a test developed based on the science

**RESULTS AND DISCUSSION**

This study aimed to analyze the effect of the Student Teams Achievement Division (STAD) cooperative learning model assisted by Mocheclay media on students' conceptual understanding of science. Quantitative data were obtained

learning outcomes for Phase D, as determined by the Ministry of Education, Culture, Research, and Technology of Indonesia (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022). These outcomes were transformed into test indicators classified under higher-order thinking skills based on the revised Bloom's taxonomy by Anderson and Krathwohl (2001). A pretest was administered before the instruction and a posttest afterward. The test consisted of 20 multiple-choice items that had been content-validated by two science education experts.

Data analysis was performed using a t-test to determine differences in pretest and posttest scores between groups. The effect size and gain score (difference between posttest and pretest scores) were used as response variables.

through pretests and posttests conducted in the experimental and control classes on the topic of elements and compounds. Descriptive statistical analysis is presented in Table 2.

**Table 2. Descriptive Statistics**

Class	N	Mean	Std. Deviation	Std. Error Mean
<b>Posttest (Control)</b>	30	73.80	10.720	1.957
<b>Posttest (Experimental)</b>	30	86.17	9.255	1.690

The results showed that the experimental group outperformed the control group in the posttest. This finding indicates that the STAD model assisted by Mocheclay media significantly improved students' conceptual understanding of science compared to direct instruction. The STAD model encouraged students to work

collaboratively and support each other in understanding the subject matter, fostering active engagement and positive social interactions during the learning process. Cooperative learning strategies like STAD have been proven effective in enhancing critical thinking, conceptual comprehension, and scientific literacy

(Ningsih & Wahyuni, 2023). This is consistent with Vygotsky's theory, which posits that learning involving social interaction enables deeper understanding through the zone of proximal development (Slavin, 2018).

These findings align with previous studies indicating that STAD can improve learning outcomes and science concept

comprehension through teamwork that promotes both individual and group accountability (Rahmawati & Putra, 2022). Therefore, implementing the STAD model can serve as an effective alternative learning strategy to enhance students' conceptual understanding at various educational levels.

**Table 3. Independent Samples T-test Results**

	<b>F</b>	<b>Sig.</b>	<b>t</b>	<b>df</b>	<b>Sig. (2-tailed)</b>	<b>Mean Difference</b>	<b>Std. Error Difference</b>	<b>95% Confidence Interval of the Difference</b>
<b>Equal variances assumed</b>	0.159	0.691	-4.783	58	0.000	-12.367	2.586	-17.543 to -7.191
<b>Equal variances not assumed</b>			-4.783	56.791	0.000	-12.367	2.586	-17.543 to -7.191

As shown in Table 3, the significance value (Sig. 2-tailed) is  $0.000 < 0.05$ , indicating a statistically significant difference between the posttest scores of the experimental and control groups. The t-value of -4.783 and a mean difference of -12.367 suggest that the experimental group achieved significantly higher conceptual understanding than the control group. The 95% confidence interval for the mean difference ranged from -17.543 to -7.191, further confirming the significance of the result.

This result demonstrates the positive impact of the STAD model assisted by Mocheclay media on students' conceptual understanding of the elements and compounds topic. The STAD model, which emphasizes teamwork, individual responsibility, and active engagement, effectively supports deeper understanding of scientific concepts (Yulianti & Hardi,

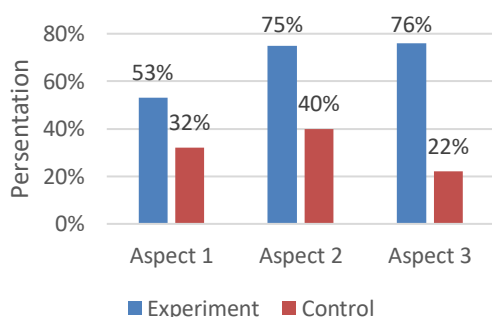
2021). Collaborative learning environments such as STAD allow students to discuss and reflect, enhancing their comprehension of concepts, processes, and skills delivered during instruction (Arisman, 2016; Fitriyani & Subekti, 2023). These findings are in line with Vygotsky's social learning theory and Slavin's constructivist principles (2018), which highlight the role of social interaction in strengthening cognitive and literacy skills.

The calculated effect size was 1.23, indicating a very large effect. Therefore, it can be concluded that the STAD model assisted by Mocheclay media had a substantial influence on students' science conceptual understanding regarding elements and compounds. This supports Wulandari and Kurniawan's (2020) findings, which suggested that the STAD model promotes active participation and

facilitates deeper conceptual comprehension.

The normalized gain (N-gain) analysis showed that the experimental class achieved a gain score of 64%, while the control class obtained 33%. These results suggest that the STAD model assisted by Mocheclay media is reasonably effective in improving students' science conceptual understanding, whereas direct instruction was not effective. The effectiveness was further confirmed by the comparison of N-gain scores between the two groups.

The assessment covered three aspects: (1) explaining the characteristics of elements and compounds, (2) analyzing their differences based on scientific data, and (3) evaluating their applications in daily life.



**Figure 1. N-Gain Score Diagram of Science Conceptual Understanding**

As illustrated in Figure 1, students in the experimental group showed moderate effectiveness in aspects 1 and 2, and high effectiveness in aspect 3. In contrast, the control group exhibited low effectiveness in aspects 1 and 3, and very low in aspect 2. These findings confirm that the STAD model assisted by Mocheclay media enhanced students' conceptual understanding of elements and compounds. This is supported by Wulandari and

Kurniawan (2020), who emphasized the role of active discussion in fostering conceptual comprehension. Additionally, group quizzes and rewards in the STAD model increased motivation and student responsibility (Yuliana & Rahayu, 2021).

The use of concrete media such as Mocheclay helped students visualize and understand the structure of elements and compounds. Molymod facilitated direct observation of molecular structures, making abstract content more accessible. Mocheclay transformed previously imagined molecular structures into 3D visual forms, enhancing clarity. According to Munika and Kurniati (2021), instructional media that provide concrete experiences can motivate students and improve learning retention. This is in line with Soleman (2022), who found that using Molymod in teaching carbon compounds had a positive impact on students' learning outcomes.

The improved learning outcomes observed with the STAD model and Mocheclay media indicate an increase in students' conceptual understanding. This is because conceptual understanding is closely related to academic performance and is shaped not only by content knowledge but also through social interaction in group learning. Luthfiyah (2020) found that discovery learning integrated with STAD and chemical representation enhanced the quality of chemistry instruction. Using alternative teaching aids such as concrete media can serve as an innovative solution for effectively delivering abstract chemistry concepts (Wiwit & Rohiat, 2019).

## CONCLUSION

The STAD cooperative learning model significantly improved students' conceptual understanding of science. It is recommended that science teachers incorporate the STAD model assisted by Mocheclay media into instruction on elements and compounds as an effective

alternative to promote active and meaningful learning. Future studies are encouraged to explore the integration of other cooperative models and media to enhance different aspects of conceptual understanding or to apply them to other science topics.

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