Cypriot Journal of Educational Sciences

Volume 20, Issue 1, (2025) 25-32

www.cjes.eu

Effect of the TTW learning model on students' critical thinking skills in Chemistry

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Suggested Citation:
Haryanto, Ernawati, M.D.W., Sudarmin, Asyhar, R., Sari, I.A. & Rivani, P.A. (2025). Effect of the TTW learning model on students' critical thinking skills in Chemistry. *Cypriot Journal of Educational Science, 20*(1), 25-32. https://doi.org/10.18844/cjes.v20i1.8148

Received from November 2, 2024; revised from December 3, 2024; accepted from January 12, 2025.
Selection and peer review under the responsibility of Prof. Dr. Hafize Keser, Ankara University, Turkey (retired)

iThenticate Similarity Rate: 11%

Abstract

Education plays a crucial role in shaping the future of a nation's generations by enhancing individuals' knowledge, skills, and abilities. One effective approach to fostering critical thinking is through the Think Talk Write (TTW) learning model, which encourages students to think, reflect, organize their ideas, and test them. Critical thinking in students is not only reflected in their ability to answer or solve problems but also in the quality of the questions they ask. This study aims to explore the impact of the TTW learning model on the critical thinking skills of chemistry students. Employing a mixed-methods research design, this study utilized simple random sampling to select participants. Data were collected through written statements to assess students' responses. The results of the regression analysis indicated a significant effect, confirming that the TTW model positively influences the critical thinking skills of students in chemistry lessons. These findings have important implications for enhancing teaching strategies and fostering critical thinking in science education.

Keywords: Chemistry; critical thinking; learning model; Think Talk Write a model

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1. INTRODUCTION

Education is used as a bridge to educate the nation's generation. The higher a person's education (Darmaji et al., 2019; Matthews, 2017), the higher his knowledge, skills, and abilities. The purpose of education is to convey knowledge to students so that they become critical, skilled, and professional human beings (Kurniawan et al., 2019; Wulandari et al., 2021; Zain et al., 2021). Learning in the 2013 curriculum is directed at empowering all the potential of students so that they can have the expected competencies. Therefore, students must be able to think at a higher level so that they can understand the concepts of the material being studied. Chemistry is a science that studies the answers to the what, why, and how of the phenomena that occur around us and their relation to the composition, structure, properties, changes, dynamics, and energy of matter involving skill and reasoning (Astuti et al., 2017; Rati et al., 2017; Redhana, 2019).

TTW model is a learning model that can build thinking, reflect, and organize ideas, then test these ideas before students are expected to write. This model is based on the understanding that learning is a social behavior (Winarni et al., 2022; Sugianto et al., 2014; Wulandari et al., 2017). The flow of TTW progress starts from the involvement of students in thinking or dialogue with themselves after the process of reading and making notes on the readings individually, then talking and sharing ideas with friends before writing in their language and helping students in collecting and developing ideas. Through certain conversations. In learning with this TTW model, the teacher directs students to find or investigate and prove for themselves the truth of a chemical concept needed to solve a problem in learning chemistry. In practice, students are trained to reason, cooperate, communicate, and formulate their conclusions from the results of their discussions or investigations (Rohika, 2017; Rumapea, 2018; Wijaya & Arismunandar, 2018). The advantage of implementing learning using the TTW learning model is that it can guide students to build their knowledge so that their understanding of the concepts being studied becomes better and can improve students' critical thinking skills

In developing a good mastery of learning concepts, students' critical thinking skills are needed. When students work on a given problem, they tend to need analytical power and to think logically (Dewi et al., 2017; Redhana, 2019; Salbiah, 2017; Dinçol Özgür, 2024). Critical thinking is the basis of the thought process to analyze arguments and generate ideas for each meaning to develop a logical mindset (García-Carmona, 2023; Plummer et al., 2022). Critical thinking in students can not only be seen from the ability of students to answer or solve problems but also can be seen from the ability and quality of questions asked by students (Ying & Tiemann 2024; Nurazizah et al., 2017; Paringin et al., 2016; Santosa, 2018).

In practice, students are trained to reason, cooperate, communicate, and formulate their conclusions from the results of their discussions or investigations (Rizki & Suprapto 2024). The advantage of implementing learning using the TTW learning model is that it can guide students to build their knowledge so that students' understanding of the concepts being studied becomes better and can improve students' critical thinking skills (O'Connor et al., 2019). Strategy can improve students' critical thinking skills. In line with the research conducted by Stender et al., (2018) It was explained that the application of the TTW model in colloidal material chemistry learning resulted in higher average student activity results than using the conventional model.

1.1. Purpose of study

The researcher intends to conduct research to look at the influence of the TTW learning model on students' critical thinking skills in chemistry lessons. To know the effect of the TTW learning model on the critical thinking skills of chemistry students.

2. Research Method

The type of method used in this study is a mixed method. Mixed methods are a combination of qualitative and quantitative methods. This research is more about testing the data so that the mix of methods used is explanatory. Explanatory itself is an explanation that prioritizes quantitative to be analyzed after that it is followed by qualitative. In the sense that a data result obtained from statistical testing will be analyzed and adjusted to the results of the qualitative analysis.

2.1. Participants

The population in this study were students of class XI natural Science SMA Adhyaksa 1 Jambi City which consisted of three classes (table 1).

Table 1

Number of Class XI students

Class	Total Students
Natural Science 1	28
Natural Science 2	28
Natural Science 3	31

Sampling was conducted using a simple random sampling technique. Each class was assigned a unique code: Natural Science 1 was coded as 1, Natural Science 2 as 2, and Natural Science 3 as 3. After assigning codes, three papers were prepared, each labeled with combinations of these codes: 1-2, 1-3, and 2-3. These papers were folded and placed into a bottle. The bottle was shaken, and one paper was drawn, which revealed the combination 1-2.

The combination 1-2 became the research sample. To further determine the experimental and control groups, the two codes were rewritten: the first code was 1, and the second code was 2. The papers were shaken again, and the number 1 was drawn, indicating that XI Natural Science 1 would serve as the control group, while XI Natural Science 2 would serve as the experimental group.

2.2. Data collection tools

Data collection was carried out by giving written statements used to obtain information from students. The observation sheet was used as a guide in conducting observations to obtain information on how the TTW model is implemented by the teacher. The assessment criteria are arranged based on the stages of the TTW learning model. Table 2 is the lattice of the observation sheet for the implementation of the TTW model by the teacher.

Table 2

Grid of the Observation Sheet for the Implementation of the TTW Model by Teachers

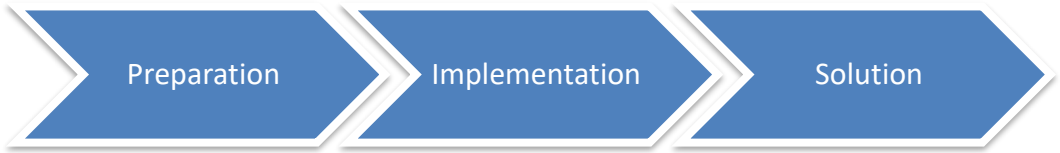
TTW Model Syntax	TTW model learning activities
Introduction	The teacher gives directions to students that an initial test will be carried out before learning begins and asks students to work on the initial test questions on the reaction rate individually. The teacher explains the basic competencies and indicators that students must achieve after learning. The teacher gives an apperception related to the material of reaction rate. The teacher motivates students to be involved in the learning process. The teacher gives the Student Worksheet (LKS) and asks students to read and understand the problems in the LKS.
Think	The teacher asks students to make small notes individually about what they know and don't know in the problem (Think) The teacher asks students to try to solve problems individually. The teacher divides the students into 4 study groups.
Talk	The teacher gives directions to students to interact and collaborate with their group friends to discuss the contents of the notes (Talk). The teacher guides students to discuss and asks students to convey ideas in discussions to produce solutions to the problems given. The teacher directs and guides students in formulating solutions to problems.
Write	The teacher asks students to formulate the knowledge they can in the form of problem solutions in writing (Write) The teacher asks students to make presentations in front of the class.

	The teacher clarifies if there is a misconception in learning the reaction rate material.
Closing	The teacher asks students to conclude the learning material about the reaction rate. The teacher gives directions to students that a final test will be carried out and asks students to work individually.
Total Questions	16

There were **16 questions used in the TTW Model Implementation Observation Grid by the Teacher**. The steps taken to obtain research data in this study are as follows (figure 1):

Figure 1

Data collection



3. RESULTS

This section presents d**ata on critical thinking test results using normality test analysis, taken from Kolmogorov-Smirnov data. The results of the homogeneity test are as** seen in Table 3**.**

Table 3

Normality test

Class	Test of Normality Kolmogorov-Smirnov		
	Statistic	Df	Sig
Natural Science 1	.157	26	0.971
Natural Science 2	.157	26	0.171

The results obtained in the sample have a significance value > 0.05; it can be concluded that the sample is normally distributed. It can be seen in Table 3 that in IPA class 1, the significance value is 0.097 > 0.05, and in IPA class 2, the significance value is 0.171 > 0.05. After the data is tested for normality, it is then tested for homogeneity to see if the sample used is homogeneous or not. The results of the homogeneity test are as follows.

Table 4

Homogeneity test

Level Statistic	Statistic	Df	Sig
.280	1	50	.599

The data in Table 4 obtained a significance value of 0.599> 0.005, it can be concluded that the data is homogeneously distributed. Hypothesis testing was conducted to see the effect of Self-efficacy on students' critical thinking skills in chemistry lessons using ANOVA analysis. The results of the regression test are as follows (Table 5).

Table 5

Regression test

Model	Unstandardized Coefficients B	Standardized Coefficients	t	Sig.
(Constant)	53.583	25.422	2.108	.040
Critical Thinking TTW	.405	.083	2.136	.045
Model	.350	.075	2.125	.038

The result is that the effect of critical thinking on the TTW model can be seen from the significance value

<0.05

3.1. Observation sheet

The implementation of the learning models was observed in two classes: one applying the TTW model and the other using the STAD model. The observation focused on the teacher's instructional actions, which were recorded as qualitative data using observation sheets. During the learning process, the application of the TTW and STAD models by the teacher was observed by a single observer.

Introduction: The teacher provides brief instructions to students, informing them that an individual initial test will be administered.

Think: The teacher asks students to observe, read, and comprehend the problems presented in the LKS.

Talk: The teacher gives directions to students, though these are brief and not uniformly applied.

Write: Students are asked to formulate solutions, but guidance is not provided evenly.

Closing: The teacher asks students to summarize the learning material.

4. DISCUSSION

Before Before the treatment, the sample was first administered a self-efficacy questionnaire. The results were then categorized into two groups: students with high self-efficacy and students with low self-efficacy. This study involved two classes: class XI IPA 1 as the control group and class XI IPA 2 as the experimental group. The control group received instruction using the STAD model, while the experimental group was taught using the Think Talk Write (TTW) model. Both groups were given essay test questions, assessing critical thinking skills, at both the beginning and the end of the learning process to measure improvements in critical thinking. After collecting the research data, the data were analyzed using an ANOVA (Analysis of Variance) with the assistance of the SPSS 21 software. Before performing the ANOVA test, the sample was tested for normality and homogeneity.

The results indicate that the Think Talk Write model has a greater impact on improving students' critical thinking skills compared to the STAD model. Based on the written test responses and observation sheets, the overall achievement of critical thinking indicators in the experimental class was higher than that in the control class. This is attributed to the active involvement of students in the learning process when using the TTW model, which emphasizes both individual and group learning. In contrast, the STAD model tends to focus more on group activities, where some students rely heavily on others, particularly those who are more academically capable. The TTW model not only promotes individual responsibility and cooperation but also enhances individual student activity.

The hypothesis testing results also show a significant effect of the TTW model on students' critical thinking skills, with an ANOVA significance level of 0.000. Since this value is less than 0.05, the research hypothesis is accepted. The TTW model fosters the improvement of students' critical thinking skills by encouraging students to construct their understanding and reasoning and to communicate that reasoning with others, aligning with constructivist learning theory.

The TTW learning model is structured in stages, with the preliminary stage focusing on providing students with an initial test to assess improvements in their critical thinking skills before and after the learning process. According to the observer's notes, the teacher did not provide clear directions regarding the initial test, but students were still able to complete it individually and quietly. However, the classroom atmosphere was not fully conducive at this stage, as many students were not paying attention to the teacher's instructions, and some students were observed copying their peers' answers during the test (Alsabahi et al., 2021).

Several improvements were made by the teacher during the second meeting to enhance the implementation of the TTW model. These included refining teaching skills and classroom management, such as giving clear instructions, providing warnings to disruptive students, offering consistent guidance, and providing reinforcement as needed. Observations from the second meeting show that the teacher effectively directed the students in completing the initial test before learning about the factors affecting reaction rates.

The students followed the teacher's instructions well, creating a more conducive environment for completing the test. The teacher also explained the basic competencies, indicators, and learning objectives for the reaction rate material, offering motivation and linking the content to real-life examples to enhance student engagement and interest. The learning process is influenced by the interaction between students and teachers, which plays a pivotal role in shaping students' learning behaviors (Kejzlarova & Mladkova, 2023; Song & Cai, 2024).

By the third meeting, the teacher had addressed the deficiencies from previous meetings, further improving the implementation of the TTW model. Classroom management skills were enhanced, particularly through efforts to engage all students. Teachers play a crucial role in fostering students' willingness to learn, and one of the factors influencing the teaching and learning process is the teacher's role in effectively planning and executing lessons.

5. CONCLUSION

The implementation of the Think Talk Write (TTW) model has a significant effect on students' critical thinking skills in relation to the reaction rate material. The average scores from the first, second, and third meetings were 71, 77, and 83, respectively. Results from the ANOVA test showed a significance value of less than 0.05, indicating an interaction between the TTW and Self-efficacy models on students' critical thinking skills in chemistry learning.

At the third meeting, the teacher made several improvements, particularly in classroom management, such as engaging with all students. Teachers play a crucial role in fostering students' willingness to learn. At the second meeting, further improvements were made to enhance the implementation of the TTW model, including refining teaching skills and better managing the classroom. These improvements involved giving clear instructions, addressing disruptive behavior, providing even guidance, and offering reinforcement when necessary.

Conflict of Interest: The authors declare no conflict of interest.

Ethical Approval: The study adheres to the ethical guidelines for conducting research.

Funding: This research received no external funding.

REFERENCES

Alsabahi, M. A., Ku Bahador, K. M., & Saat, R. M. (2021). The influence of personal characteristics and workplace learning on information technology competency among external auditors: The role of organizational culture as a moderator. *Cogent business & management*, *8*(1), 1899625. https://www.tandfonline.com/doi/abs/10.1080/23311975.2021.1899625

Astuti, S., Subagia, I. W., & Sudiana, I. K. (2017). Student'satisfaction toward the chemistry learning process at SMA Laboratorium undiksha. *JPI (Jurnal Pendidikan Indonesia)*, *6*(2), 233-241. https://ejournal.undiksha.ac.id/index.php/JPI/article/view/11880

Darmaji, D., Astalini, A., Dwi Agus Kurniawan, D., Perdana, R., & Putra, D. S. (2019). A Study Relationship Attitude Toward Physics, Motivation, and Character Discipline Students Senior High School in Indonesia. *International Journal of Learning and Teaching*. https://repository.unja.ac.id/12954/1/24.%20Astalini%20A%20Study.pdf

Dewi, N. P. S. R., Wibawa, I. M. C., & Devi, N. L. P. L. (2017). Kemampuan berpikir kritis dan keterampilan proses dalam pembelajaran siklus belajar 7e berbasis kearifan lokal. *JPI (Jurnal Pendidikan Indonesia)*, *6*(1), 125-133. https://ejournal.undiksha.ac.id/index.php/JPI/article/view/9476

Dinçol Özgür, S. (2024). The effects of prospective chemistry teachers' laboratory teaching experiences on their metacognitive thinking skills and perceptions of problem-solving skills. *European Journal of Psychology of Education*, *39*(3), 2057-2082. https://link.springer.com/article/10.1007/s10212-023-00760-y

Haryanto, Ernawati, M.D.W., Sudarmin, Asyhar, R., Sari, I.A. & Rivani, P.A. (2025). Effect of the TTW learning model on students' critical thinking skills in Chemistry. *Cypriot Journal of Educational Science, 20*(1), 25-32. https://doi.org/10.18844/cjes.v20i1.8148

García-Carmona, A. (2023). Scientific thinking and critical thinking in science education: Two distinct but symbiotically related intellectual processes. *Science & Education*, 1-19. https://link.springer.com/article/10.1007/s11191-023-00460-5

Kejzlarova, N., & Mladkova, L. (2023). Student stories as the source of knowledge for decision-making–mixed method study from the university. *Knowledge Management Research & Practice*, *21*(1), 165-182. https://www.tandfonline.com/doi/abs/10.1080/14778238.2020.1855088

Kurniawan, D. A., Astalini, A., Kurniawan, N., & Pathoni, H. (2019). Analisis korelasi sikap siswa dan disiplin siswa terhadap IPA pada Siswa SMP Provinsi Jambi. *Jurnal Pendidikan Fisika dan Keilmuan (JPFK)*, *5*(2), 59-71. https://e-journal.unipma.ac.id/index.php/JPFK/article/view/5014

Matthews, M. R. (Ed.). (2017). *History, philosophy, and science teaching: New perspectives*. Springer. https://books.google.com/books?hl=en&lr=&id=_3IzDwAAQBAJ&oi=fnd&pg=PR5&dq=Matthews,+M.+R.+(2018).+History,+philosophy+and+science+teaching%E2%80%AF:+new+perspectives.+Springer.&ots=WoS8Ml4Y3l&sig=77hH-Hs9t3gQ_5lQbcs4OukcMlo

Nurazizah, S., Sinaga, P., & Jauhari, A. (2017). Profil kemampuan kognitif dan keterampilan berpikir kritis siswa sma pada materi usaha dan energi. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *3*(2), 197-202. https://pdfs.semanticscholar.org/c63a/13013f506fad42d15cdf4814bc4245f1f4fd.pdf

O'Connor, P. J., Hill, A., Kaya, M., & Martin, B. (2019). The measurement of emotional intelligence: A critical review of the literature and recommendations for researchers and practitioners. *Frontiers in Psychology*, *10*, 429307. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2019.01116/full?amp=1

Paringin, S., Mata, P., & Ipa, P. (2016). *Analisis Kemampuan Berpikir Kritis Siswa Kelas Ix*. *2006*, 179–186.

Plummer, K. J., Kebritchi, M., Leary, H. M., & Halverson, D. M. (2022). Enhancing critical thinking skills through decision-based learning. *Innovative Higher Education*, *47*(4), 711-734. https://link.springer.com/article/10.1007/s10755-022-09595-9

Rati, N. W., Kusmaryatni, N., & Rediani, N. (2017). Model pembelajaran berbasis proyek, kreativitas dan hasil belajar mahasiswa. *JPI (Jurnal Pendidikan Indonesia)*, *6*(1), 60-71. https://ejournal.undiksha.ac.id/index.php/JPI/article/view/9059

Redhana, I. W. (2019). Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. *Jurnal inovasi pendidikan kimia*, *13*(1). https://journal.unnes.ac.id/nju/jipk/article/view/17824

Rizki, I. A., & Suprapto, N. (2024). Project-oriented, problem-based learning through SR-STEM to foster students' critical thinking skills in renewable energy material. *Journal of Science Education and Technology*, *33*(4), 526-541. https://link.springer.com/article/10.1007/s10956-024-10102-2

Rohika, D. P. (2017). Peningkatan hasil belajar IPA melalui penerapan model kooperatif tipe student team achievement division (STAD) pada siswa kelas IV SD No. 2 Beng Gianyar tahun pelajaran 2015/2016. *Jurnal Ilmiah Sekolah Dasar*, *1*(3), 221-228. https://ejournal.undiksha.ac.id/index.php/JISD/article/view/12007

Rumapea, R. (2018). Pengaruh Model Pembelajaran Kooperatif Tipe Stad dan Pemberian Soal Open Ended Terhadap Kemampuan Pemecahan Masalah Siswa Ditinjau dari Kemampuan Awal Matematika. *Pendidikan Matematika*, *12*(1), 1–14. https://ejournal.unsri.ac.id/index.php/jpm/article/view/4551/pdf

Salbiah, S. (2017). Profil keterampilan berpikir kritis siswa menggunakan pembelajaran discovery inquiry pada konsep koloid. *JTK (Jurnal Tadris Kimiya)*, *2*(1), 109-115. https://journal.uinsgd.ac.id/index.php/tadris-kimiya/article/view/1367

Santosa, F. H. (2018). Pengaruh model pembelajaran dan kemampuan berpikir kritis terhadap hasil belajar sejarah siswa di SMA Negeri 1 Pandeglang. *Jurnal Teknologi Pendidikan*, *20*(1). https://core.ac.uk/download/pdf/304321448.pdf

Song, H., & Cai, L. (2024). Interactive learning environment as a source of critical thinking skills for college students. *BMC Medical Education*, *24*(1), 270. https://link.springer.com/article/10.1186/s12909-024-05247-y

Stender, A., Schwichow, M., Zimmerman, C., & Härtig, H. (2018). Making inquiry-based science learning visible: the influence of CVS and cognitive skills on content knowledge learning in guided inquiry. *International*

Haryanto, Ernawati, M.D.W., Sudarmin, Asyhar, R., Sari, I.A. & Rivani, P.A. (2025). Effect of the TTW learning model on students' critical thinking skills in Chemistry. *Cypriot Journal of Educational Science, 20*(1), 25-32. https://doi.org/10.18844/cjes.v20i1.8148

Journal of Science Education, *40*(15), 1812-1831. https://www.tandfonline.com/doi/abs/10.1080/09500693.2018.1504346

Sugianto, S., Armanto, D., & Harahap, M. B. (2014). Perbedaan penerapan model pembelajaran kooperatif tipe jigsaw dan STAD ditinjau dari kemampuan penalaran dan komunikasi matematis siswa SMA. *Jurnal Didaktik Matematika*, *1*(1). https://jurnal.usk.ac.id/DM/article/view/1332

Wijaya, H., & Arismunandar, A. (2018). Pengembangan model pembelajaran kooperatif tipe stad berbasis media sosial. *Jurnal Jaffray*, *16*(2), 175-196. https://www.neliti.com/publications/265649/pengembangan-model-pembelajaran-kooperatif-tipe-stad-berbasis-media-sosial

Winarni, S., Rohati, R., Rivani, P. A., & Azzahra, M. Z. (2022). The Comparison of Jigsaw Cooperative Learning Model with STAD on Mathematics Subjects in Junior High School. *Journal of Education Research and Evaluation*, *6*(1), 118-130. https://ejournal.undiksha.ac.id/index.php/JERE/article/view/40425

Wulandari, M., Astalini, A., & Darmaji, D. (2021). Analisis kebutuhan mahasiswa terhadap pengembangan e-modul fisika matematika i di program studi pendidikan fisika FKIP Universitas Jambi. *Jurnal Pendidikan MIPA*, *11*(2), 23-28. https://ejournal.tsb.ac.id/index.php/jpm/article/view/473

Wulandari, T. S. H., Amin, M., Zubaidah, S., & IAM, M. H. (2017). Students' Critical Thinking Improvement through" PDEODE" and" STAD" Combination in the Nutrition and Health Lecture. *International Journal of Evaluation and Research in Education*, *6*(2), 110-117. https://eric.ed.gov/?id=EJ1145235

Ying, Y., & Tiemann, R. (2024). Development of an assessment tool for collaborative problem-solving skills in chemistry. *Disciplinary and Interdisciplinary Science Education Research*, *6*(1), 25. https://link.springer.com/article/10.1186/s43031-024-00116-6

Zain, M. S., Astalini, A., & Kurniawan, D. A. (2021). The Influence of Reading Fondness Characters on Students' Attitudes in Science Subjects in Junior High Schools. *Indonesian Journal Of Educational Research and Review*, *4*(1), 122-132. https://ejournal.undiksha.ac.id/index.php/IJERR/article/view/32483