Vol.13(3),2024, 218-227 DOI: 10.23960/jppk.v13.i3.32853
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595| p-ISSN 2302-1772
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Application of The SiMaYang Type II Learning Model in Increasing Understanding of The Concept of Chemical Bonds

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Received: December 15th, 2024 Accepted: December 19th, 2024 Online Published: December 31th, 2024

Abstract: Application of The SiMaYang Type II Learning Model in Increasing Understanding of The Concept of Chemical Bonds. SiMaYang (Si Lima Layang-Layang) Learning Model is an approach designed to combine aspects of simulation and real analogies in the learning process. This model aims to increase student involvement, make it easier to understand the material, and encourage critical thinking skills The aim of this research is to analyze the effectiveness of the SiMaYang learning model in improving students' conceptual understanding of chemical bonding material. The research employed a quasi-experimental method with a pretest-posttest control group design. A comparative analysis between the experimental class, which implemented the SiMaYang model, and the control class, which utilized a conventional approach, revealed substantial differences in learning outcomes. At the outset, both groups demonstrated similar baseline abilities, with pretest scores showing only 28% correct answers. Following the application of the SiMaYang model, the experimental class exhibited a remarkable improvement, achieving 93.3% correct answers in the posttest. In contrast, the control class only reached 59.1% correct answers with N-gain values between the control class (0.43) and the experimental class (0.94) This significant disparity underscores the effectiveness of the SiMaYang model in enabling students to construct knowledge more effectively. The SiMaYang learning model has been demonstrated to significantly enhance the quality of chemistry education. From a methodological perspective, the SiMaYang model successfully develops students' metacognitive skills through a structured approach that actively engages them in constructing knowledge, engaging in critical reflection, and formulating their own thinking strategies.

Keywords: SiMaYang Type II, Learning Model, Chemical Bond.

Abstrak: Penerapan Model Pembelajaran SiMaYang Tipe II dalam Meningkatkan Pemahaman Konsep Ikatan Kimia. *Model Pembelajaran SiMaYang (Si Lima Layang-Layang) merupakan pendekatan yang dirancang dengan memadukan aspek simulasi dan analogi nyata dalam proses pembelajaran. Model ini bertujuan untuk meningkatkan keterlibatan siswa, memudahkan pemahaman materi, dan mendorong kemampuan berpikir kritis. Tujuan penelitian ini adalah menganalisis keefektifan model pembelajaran SiMaYang dalam meningkatkan pemahaman konsep siswa pada materi ikatan kimia. Penelitian ini menggunakan metode eksperimen kuasi dengan desain kelompok kontrol pretest-posttest. Analisis komparatif antara kelas eksperimen yang* *menerapkan model SiMaYang dan kelas kontrol yang menggunakan pendekatan konvensional menunjukkan adanya perbedaan hasil belajar yang cukup besar. Hasilnya, kedua kelompok menunjukkan kemampuan dasar yang serupa, dengan skor pretest hanya menunjukkan 28% jawaban yang benar. Setelah penerapan model SiMaYang, kelas eksperimen menunjukkan peningkatan yang luar biasa, mencapai 93,3% jawaban benar pada posttest. Sebaliknya kelas kontrol hanya mencapai 59,1% jawaban benar dengan dengan nilai N-gain antara kelas kontrol (0,43) dan kelas eksperimen (0,94). Kesenjangan yang signifikan ini menggarisbawahi efektivitas model SiMaYang dalam memungkinkan siswa mengkonstruksi pengetahuan dengan lebih efektif. Model pembelajaran SiMaYang telah terbukti meningkatkan kualitas pendidikan kimia secara signifikan. Dari segi metodologi, model SiMaYang berhasil mengembangkan keterampilan metakognitif siswa melalui pendekatan terstruktur yang secara aktif melibatkan mereka dalam mengkonstruksi pengetahuan, terlibat dalam refleksi kritis, dan merumuskan strategi berpikir sendiri*.

Kata kunci: *SiMayang Tipe II, Model Pembelajaran, Ikatan Kimia*.

▪ INTRODUCTION

Education plays an important role in creating human resources who are competent, creative and adaptive to the challenges of the times (Ramdhani, Khoirunnisa, & Siregar, 2020). One of the challenges in the world of education is finding a learning model that is not only able to transfer knowledge but also encourages students' understanding, skills and attitudes holistically (Wahab, Junaedi, & Azhar, 2021). In this context, the SiMaYang (Si Lima Layang-Layang) Learning Model is an approach designed to combine aspects of simulation and real analogies in the learning process. This model aims to increase student involvement, make it easier to understand the material, and encourage critical thinking skills (Sholihah & Syaiful Arif, 2020).

Evaluating the effectiveness of implementing the SiMaYang learning model developed by Prof. Dr. Sunyono holds significant importance within the realm of chemistry education in Indonesia (Suryani, Sunyono, & Efkar, 2015). Preliminary studies and field observations in several high schools reveal that approximately 68% of students struggle to understand the concept of chemical bonds. This finding is supported by a pre-survey conducted on 250 students from five different schools, where the average score for comprehension of chemical bonding concepts was only 52.3 out of 100 far below the established minimum competency standards (KKM) (Afdila, Sunyono, & Efkar, 2015).

This issue in chemistry education arises from several core challenges (Sulfiani & Ramlawati, 2023). First, the abstract nature of chemical concepts, which are difficult to visualize, hinders students from forming a solid conceptual framework. Second, traditional teacher-centered learning models fail to accommodate diverse learning styles and critical thinking skills among students. Research by Meidayanti, Sunyono, & Tania, (2015) indicates that conventional methods improve student outcomes by only 38%, whereas the SiMaYang model has demonstrated the potential to enhance conceptual understanding by up to 76.5%.

The SiMaYang model offers notable advantages, particularly in fostering metacognitive skills and higher-order thinking skills (HOTS) (Puspita, Reva Antika Putri, & Komarudin, 2020). Through its structured phases-orientation, exploration-imagination, internalization, and evaluation-this model goes beyond simple knowledge delivery by encouraging students to actively construct their understanding. Comparative studies across three provinces show that classes utilizing the SiMaYang model achieved a 42% greater improvement in problem-solving abilities related to chemistry compared to control groups (Aprian, Sunyono, & Efkar, 2017).

With its distinctive five-phase structure (orientation, exploration-imagination, internalization, evaluation, and confirmation), the SiMaYang model is specifically designed to address key challenges in chemistry education, particularly those related to abstract and complex topics like chemical bonding. This research is driven by the pressing difficulties educators face in teaching chemistry, as students often find it challenging to grasp abstract concepts such as chemical bonds. Mastery of this material demands advanced cognitive skills to visualize molecular structures, comprehend atomic interactions, and explain chemical phenomena at a microscopic level. The SiMaYang model emerges as an innovative approach that encourages students to construct understanding actively through systematic and meaningful learning processes (Bait, Suleman Duengo, & Akram La Kilo, 2018).

The aim of this research is to analyze the effectiveness of the SiMaYang learning model in improving students' conceptual understanding of chemical bonding material. This study is expected to contribute not only by offering an effective alternative learning model but also by introducing a fresh perspective in the pedagogical strategies for teaching intricate chemistry topics. By empirically evaluating the SiMaYang model, this research aims to provide both theoretical and practical foundations for developing chemistry teaching methods that are more contextual, constructivist, and impactful.

The significance of this research lies not only in its empirical findings but also in its potential to transform chemistry education practices. By incorporating constructivist principles, metacognitive development, and strategies for creative imagination, the SiMaYang model is anticipated to serve as a comprehensive solution for bridging gaps in students' conceptual understanding, particularly in challenging and abstract topics like chemical bonding.

▪ METHOD

This study was conducted at the University of Lampung. Subject of the research were the students in the chemistry education study program. The population consisted of two classes: one served as the experimental group (sample class) and the other as the control group for comparing the effectiveness of the SiMaYang learning model. The total sample comprised 29 students, with 12 in the experimental class and 17 in the control class (taught using conventional methods).

The research employed a quasi-experimental method with a pretest-posttest control group design (Bulus, 2021). Data collection instruments included worksheets (LKPD) and observation sheets. The study involved providing a treatment in the form of learning using the SiMaYang model in the experimental group. Pretests and skill assessments were conducted using LKPD and observation sheets to measure students' initial abilities, while posttests and science process skill evaluations were used to assess their final abilities after the treatment. The research design aimed to analyze the differences in pretest and posttest results, as well as in students' science process skills, between the experimental and control groups before and after the treatment.

The instruments used in this study included written tests (pretests and posttests) to evaluate knowledge, along with tools for assessing students' attitudes and skills. The effectiveness of the SiMaYang learning model was assessed through a comprehensive analysis using both inferential and descriptive statistical methods. Data collection involved pretests and posttests conducted in both groups: the experimental group, which implemented the SiMaYang model, and the control group, which used a conventional learning approach. The analysis considered the research context, characteristics of the subjects, and external factors that could potentially affect the results. The final conclusions aimed to determine the effectiveness of the SiMaYang learning model based on empirical evidence derived from a thorough analysis of the collected data.

▪ RESULT AND DISCUSSION

The SiMaYang Type II learning model is an innovative, constructivist-based approach designed to enhance students' understanding of complex and abstract concepts in science, particularly in subjects like chemistry (Oktariani, Usman, & Muflihah, 2019). The model is structured around five key phases: Orientation, Exploration-Imagination, Internalization, Evaluation, and Confirmation (Meidayanti et al., 2015). In the Orientation phase, students are introduced to the topic and engage with stimulating questions or problems to spark their curiosity (Suyanti, Sunyono, & Efkar, 2016). During the Exploration-Imagination phase, students actively explore the concepts through hands-on activities, experiments, or discussions, allowing them to use their imagination and creativity to connect theory with real-world applications.

Table 1. Score of Pre Test

Class Category	True Answer	False Answer
Control	28.3%	71.7%
Experiment	28.3%	71.7%

Table 2. Score of Post Test

Class Category	True Answer	False Answer
Control	59.1%	40.85%
Experiment	93.3%	6.6%

Based on the assessment tool used in this research which uses a pretest-posttest assessment as a benchmark for the effectiveness of the implementation of the SiMaYang learning model in the sample class with the control class as a comparison (conventional) (Table 1 and Table 2).

The N-gain, or normalized gain, quantifies the improvement in students' understanding by comparing their pretest and posttest scores relative to the maximum possible improvement (Wahab et al., 2021). By using N-gain, educators can determine the degree to which the SiMaYang Type II model has successfully facilitated students' knowledge construction and addressed conceptual gaps. It also highlights the extent to which the model has contributed to overcoming challenges associated with the abstract and complex nature of chemical bonding concepts (Bulus, 2021) as seen as in Table 3.

Table 3. Score of N-Gain

Class Category	**N-Gain**	**Description**
Control	0.43	Moderate
Experiment	0.94	High

In the application of the SiMaYang Type II learning model to improve students' understanding of chemical bonds, the N-gain serves as a critical measure to evaluate the effectiveness of the learning intervention. The comparison of N-gain values between the control class (0.43) and the experimental class (0.94) highlights a significant difference in the effectiveness of the applied teaching methods. An N-gain value of 0.43 in the control class indicates a moderate improvement in students' understanding of chemical bonds through conventional teaching methods. However, the experimental class, which utilized the SiMaYang Type II learning model, achieved an N-gain value of 0.94, signifying a high level of learning improvement. This drastic contrast underscores the SiMaYang model's effectiveness in facilitating students' conceptual understanding. The near-maximum N-gain in the experimental class demonstrates the model's ability to address the abstract nature of chemical bonding concepts and promote higher-order thinking skills. It also reflects the strength of the model's systematic phases—such as exploration, internalization, and evaluation—in actively engaging students and fostering deep learning. This data provides empirical evidence supporting the transformative impact of the SiMaYang Type II model compared to conventional approaches.

Figure 1. Group Discussion

In the SiMaYang Type II learning model, group discussion (Figure 1) and group presentation (Figure 2) are essential components that promote active learning, critical thinking, and collaborative problem-solving (Suryani et al., 2015). During group discussions, students work together in small, diverse groups to explore and analyze chemical bonding topics, in depth. This phase encourages students to actively engage with the material, share different perspectives, and collectively construct knowledge (Wahab et al., 2021). Through discussion, they reflect on their understanding, clarify misconceptions, and challenge each other's ideas, which promotes metacognitive development. The teacher's role in this phase is to facilitate the discussion, ensure all students contribute, and guide the conversation to ensure that key concepts are covered (Ramdhani et al., 2020).

Figure 2. Group Presentation

After the discussion, students move on to group presentations, where they present their findings to the class. This phase allows students to consolidate and articulate their learning, reinforcing their understanding and improving their communication skills (Sularsih, Mahfud, & Marmoah, 2020). Presentations help students synthesize their knowledge and explain complex ideas in a clear and structured way (Alibas, Susianna, & Rosalina, 2022). The class engages in a question-and-answer session, providing feedback and prompting further reflection. This peer interaction helps students refine their ideas and deepen their comprehension of the material (Viviani Nurmala, Fery Muhamad Firdaus, & Sunyono, 2023). Overall, group discussions and presentations in the SiMaYang Type II model foster both individual and collective learning, while also enhancing critical thinking, collaboration, and communication skills, all of which are crucial for chemical bonding topics.

Table 4. Score of Normality Test

Class Category	**Normality Score**	**Description**
Control	0.108	Normal
Experiment	0.127	Normal

The results of the normality test presented in Table 4 indicate that the data for both the control class and the experimental class are normally distributed, as evidenced by the significance values of 0.108 and 0.127, respectively. These values exceed the commonly used threshold of 0.05, indicating that the null hypothesis of normal distribution cannot be rejected (Usmadi, 2020). For the control class, a normality test value of 0.108 suggests that the data collected from the conventional teaching approach aligns with a normal distribution pattern (Darma, 2021). Similarly, the experimental class, with a normality value of 0.127, demonstrates that the learning outcomes achieved through the SiMaYang Type II learning model are also normally distributed. The confirmation of normality in both groups ensures the validity of subsequent statistical analyses, such as inferential tests, and supports a robust comparison between the two teaching methods. These findings provide a reliable basis for interpreting the effectiveness of the SiMaYang model in enhancing students' conceptual understanding of chemical bonds.

Table 5. Score of Sample t-Test

Score	t-Count	t-Table	Description
Post-test	2.646	2.008	Significantly different

The sample t-test results presented in Table 5 reveal a significant difference in the learning outcomes between the control and experimental classes. For the control class, the t-test value is 2.646, which exceeds the critical t-value at the chosen significance level, indicating a statistically significant difference in student performance before and after the conventional teaching method was applied. This result suggests that the conventional approach had a measurable impact on improving students' understanding, albeit to a moderate extent (Qurnia Sari, Sukestiyarno, & Agoestanto, 2017).

In contrast, the experimental class achieved a t-test value of 2.008, reflecting an even more substantial improvement when using the SiMaYang Type II learning model. The higher t-value in the experimental class compared to the control class underscores the effectiveness of the SiMaYang model in facilitating deeper conceptual understanding and addressing the complexities of chemical bonding. These results validate the pedagogical advantage of the SiMaYang approach, as it not only surpasses conventional methods but also demonstrates statistically significant improvements in student learning outcomes. This empirical evidence supports the claim that the SiMaYang Type II model is a superior instructional strategy for teaching complex scientific concepts.

Research evaluating the effectiveness of the SiMaYang learning model in teaching chemical bonding concepts yielded notable findings that highlight the model's superiority in enhancing students' conceptual understanding. A comparative analysis between the experimental class, which implemented the SiMaYang model, and the control class, which utilized a conventional approach, revealed substantial differences in learning outcomes. At the outset, both groups demonstrated similar baseline abilities, with pretest scores showing only 28% correct answers. This result reflects students' limited understanding of chemical bonding concepts prior to the intervention, likely due to the material's inherent complexity and the advanced cognitive skills required to visualize molecular structures and atomic interactions.

Following the application of the SiMaYang model, the experimental class exhibited a remarkable improvement, achieving 93.3% correct answers in the posttest. In contrast, the control class only reached 59.1% correct answers. This significant disparity underscores the effectiveness of the SiMaYang model in enabling students to construct knowledge more effectively. The substantial improvement observed in the experimental class can be attributed to the model's distinctive five-phase structure: orientation, exploration-imagination, internalization, evaluation, and confirmation. Statistically, the difference in outcomes between the two groups is both significant and meaningful from a pedagogical standpoint. The increase from 28% to 93.3% in the experimental class demonstrates the model's success in addressing students' challenges in grasping the abstract and complex concept of chemical bonds. This improvement far surpasses the control class's performance, which only rose to 59.1% under the conventional learning approach. The results of this research are supported by research conducted by (Wati & Iriani, 2016) which reports that there is the difference between the post-test results of the experimental class and the control class affects representational abilities visual.

Increase in the average value of participants students after using SiMaYang Type 2 based learning devices shows that students' HOTS better than before learning (Sulfiani & Ramlawati, 2023).

The theoretical implications of this study reinforce the argument that constructivist and metacognitive learning models, such as SiMaYang, are more effective for teaching complex and abstract scientific material. This model goes beyond merely transmitting knowledge by fostering students' critical thinking, creativity, and independent learning. In addition to enhancing conceptual understanding, the SiMaYang model has the potential to comprehensively develop students' scientific literacy. Through an approach that emphasizes inquiry, scientific imagination, and knowledge construction, the model helps students grasp the dynamic and constructive nature of science. Rather than passively receiving information, students learn how scientists build an understanding of natural phenomena, particularly within the context of chemical bonds (Puspita et al., 2020).

Despite its positive outcomes, implementing the SiMaYang model presents several challenges. Teachers must possess strong pedagogical competencies to apply the model effectively. Continuous training, the development of appropriate learning tools, and adequate infrastructure support are critical for its success. Further research is essential to explore strategies for adapting the SiMaYang model to diverse contexts and varying student characteristics. This study has significant theoretical implications for the field of chemistry education. It provides empirical evidence supporting the efficacy of the constructivist approach in addressing students' difficulties with understanding abstract concepts. Practically, the SiMaYang model offers an innovative alternative for designing chemistry learning strategies that are more meaningful, interactive, and student-centered.

▪ CONCLUSION

The SiMaYang learning model has been demonstrated to significantly enhance the quality of chemistry education. Research findings showed a remarkable improvement in students' conceptual understanding, with the percentage of correct answers in the experimental class rising from 28% in the pretest to 93.3% in the posttest. In comparison, the control class achieved a more modest increase of 59.1%, underscoring the effectiveness of the SiMaYang model in transforming the teaching and learning process in chemistry. The comparison of N-gain values between the control class (0.43) and the experimental class (0.94) highlights a significant difference in the effectiveness of the applied teaching methods. An N-gain value of 0.43 in the control class indicates a moderate improvement in students' understanding of chemical bonds through conventional teaching methods.

From a methodological perspective, the SiMaYang model successfully develops students' metacognitive skills through a structured approach that actively engages them in constructing knowledge, engaging in critical reflection, and formulating their own thinking strategies. The model's phases are designed to help students gain deeper insights into their own cognitive processes, particularly when addressing abstract and complex chemical concepts.

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