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Differences Between the PjBL and IBL Models Assisted by Animated Videos on Chemistry Learning Outcomes

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***Abstract*:** *Understanding chemical bonding remains challenging for secondary school students' due to its abstract nature, often leading to suboptimal learning outcomes. This study investigates the effect of instructional models on students' learning outcomes by comparing Project-Based Learning (PjBL) and Inquiry-Based Learning (IBL) supported by animated video media. A quasi-experimental design with a non-equivalent control group pretest–posttest approach was employed. The sample consisted of Grade X students' at SMA Negeri 11 Medan, selected through purposive sampling and divided into two experimental groups. Data were analyzed using Shapiro–Wilk normality test, Levene's homogeneity test, and Independent Sample t-test. The results indicate a statistically significant difference between the groups Sig. (2-tailed) < α (0.007 < 0.05), with higher mean scores observed in the PjBL group. The effect size (Cohen's d = 1.01) suggests a large and practically meaningful impact. These findings demonstrate that PjBL, when integrated with animated video media, is more effective than IBL in improving students' understanding of chemical bonding. The study highlights the importance of aligning instructional models with appropriate learning media to enhance conceptual learning outcomes.*

***Keywords*:** *project based learning; inquiry based learning; learning outcomes; animated videos; chemical bonds.*

INTRODUCTION

Education is essentially a mechanism for transferring and internalizing competencies from educators to students' (Priliyanti et al., 2021). In practice, the Indonesian educational system still faces numerous challenges across a range of fundamental issues (Lestari et al., 2023). These issues encompass the curriculum, educational quality, teacher competency, and leadership capabilities at various levels (Tintingon et al., 2023).

The field of chemistry is frequently viewed as a complex subject because it requires students' to understand and translate macroscopic phenomena into submicroscopic concepts such as atoms and molecules (Ritonga et al., 2021). Chemical bonding is a key component of chemistry at the senior high school level. However, in practice, most students' struggle to understand the concepts of chemical bonding (Togatorop & Kumajas, 2023). The high difficulty of chemical bonding stems from the fact that it demands a strong understanding at the submicroscopic level (Ramdhani et al., 2020).

Based on observational data and interviews with chemistry teachers at Medan State Senior High School 11, it was discovered that tenth-grade students' still experience various cognitive challenges in mastering concepts, particularly regarding chemical bonds. These challenges have implications for student conceptual understanding and poor learning outcomes. This is evident in the average grades, which remain below the Learning Objective Achievement Criteria (KKTP = 80), with 65% of students' scoring below 50.

Student learning success is also influenced by the implementation of engaging learning models (Artawan et al., 2020). One model deemed capable of meeting these criteria is Project-Based Learning (PjBL) (Muliaman, 2021). The effectiveness of the PjBL model is supported by several studies that found that the implementation of PjBL has a significant impact on improving student learning outcomes (Ismuwardani et al., 2019).

Beyond the Project-Based Learning (PjBL) framework, the inquiry-based learning (IBL) model serves as a viable instructional alternative (Panggabean et al., 2024). Previous researchers have shown that the application of Inquiry-Based Learning (IBL) can stimulate chemistry learning activities and outcomes in chemical equilibrium (Sukmawati, 2020). The IBL model provides students' with opportunities to learn according to their individual learning styles (Namira & Kweldju, 2022).

In the context of interactive learning, animated videos play a strategic role in increasing student interest and understanding (Oktiani, 2017). From a cognitive perspective, the application of animated videos has the potential to enhance student academic achievement (Susanti et al., 2023).

In light of the background described above, this study is designed to examine the differing levels of efficacy between the Project Based Learning (PjBL) and Inquiry Based Learning (IBL) models supported by animated video media on students' chemistry learning outcomes in the chemical bonding material, and to identify learning models that provide a more optimal influence on improving student learning outcomes. Based on the research objectives, the hypotheses of this study are formulated as follows:

H_0 : There is no significant difference in students' learning outcomes between those taught using the PjBL model and those taught using the IBL model assisted by animated video media on chemical bonding material.

H_a : There is a significant difference in students' learning outcomes between those taught using the PjBL model and those taught using the IBL model assisted by animated video media on chemical bonding material.

LITERATURE REVIEW

A. Project Based Learning (PjBL) Model

The Project-Based Learning (PjBL) model is a student-centered learning approach designed to provide a more meaningful learning experience through the process of creating a product or work (Johana et al., 2023). In PjBL, students' are given challenging and quite complex projects, yet realistic and comprehensive (Ibrahim & Sutiani, 2025). PjBL does not emphasize memorizing theories or formulas, but rather students' are expected to be more analytical and critical when evaluating information to solve problems through projects so that this learning model has a positive effect on student learning outcomes (Perangin Angin & Juwitaningsih, 2023).

The syntax of the PjBL model is as follows: 1) Fundamental questions; 2) Designing steps; 3) Developing a project implementation schedule; 4) Project completion; 5) Report preparation and presentation/publication of project results; 6) Assessment of the project's execution and its subsequent outcomes (Nirmayani et al., 2021). Based on this syntax, educators direct students' to carry out learning according to the predetermined syntax.

The PjBL model has several benefits, including:

1) Helping students' develop their understanding of the issues they face in life;
2) Facilitating students' with empirical experiences to foster critical thinking skills and hone applicable competencies relevant to everyday life;
3) Aligning the learning process with modern pedagogical principles through the holistic development of student competencies, across theoretical, practical, and implementation domains.

In addition to its benefits, this model also has several drawbacks, namely:

1) High student activity can create a less conducive classroom atmosphere, requiring a few minutes for students' to engage in active discussion. After a discussion deemed sufficient, the data analysis stage can be carried out more comprehensively;
2) Although the time allocation for students' has been determined, the learning dynamics in the classroom are sometimes not fully optimal. As a solution, teachers can allocate proportional additional time to each group on a rotating basis (Anggraini & Wulandari, 2020).

B. Inquiry Based Learning (IBL) Model

Inquiry learning, or etymologically known as the heuristic method from the greek heuriskein (I find), requires an open, democratic learning environment conducive to student discussion. This model emphasizes data-based hypothesis testing, with the reliability of facts being the primary foundation of the evaluation process (Hulu et al., 2023). Its primary focus is optimizing student participation, methodologically guiding the learning process to achieve instructional objectives, and building student confidence in their independent findings (Mauk et al., 2022).

The stages in implementing inquiry learning are as follows: 1) Orientation; 2) Problem Formulation; 3) Hypothesis Formulation; 4) Data Collection; 5) Hypothesis Testing; 6) Conclusion Formulation (Prasetiyo & Rosy, 2020). Inquiry aims to sharpen students' critical thinking and provide them with greater opportunities to improve their learning outcomes by guiding them to find solutions to the problems they have studied.

Some of the advantages of the inquiry learning model:

1) Stimulates student's readiness to learn
2) Facilitates student's independent construction of knowledge
3) Accelerates student's motivation and enthusiasm for learning, thus encouraging them to be more actively and diligently involved in the learning process.
4) Provides opportunities for growth and development
5) Increases and enhances self-confidence through the process of discovery (Hanafiah & Suhana, 2012:78).

Despite the advantages of the inquiry-based learning model, this approach has several disadvantages, including:

1) Many teachers face challenges when planning lessons due to students' diverse learning experiences.
2) Requires more time than conventional

teaching methods.

3) The inquiry model is less flexible for application to large classes with a large number of students.

If the parameters of instructional success are solely focused on conceptual mastery of the material, this model tends to be difficult for educators to accommodate within existing classroom dynamics(Lovisia, 2018).

C. Learning Outcomes

Learning outcomes are a conception of a student's development or progress during learning, starting from entering the world of education until the end of the world of education they are undergoing (Susanty, 2022). Because learning itself is a process in which a person tries to achieve relatively permanent changes in manner (Silitonga et al., 2022). In this context, learning represents a student's transition toward new behavioral patterns triggered by specific stimuli. Consequently, the hallmark of having learned is the ability to display a clear change in one's actions and responses (Susanti et al., 2022).

In the learning process, students' learning outcomes are shaped by a variety of determinants, which can be broadly categorized into internal and external factors as follows:

a. Internal factors arise from within the individual, including psychological and physical factors.
b. External factors arise from outside the individual, including school, community environment and family factors (Panggabean et al., 2023).

D. Animated Video Learning Media

Animated media is defined as multimedia that synergizes text, graphic, and audio elements into moving visualizations to create attractive and effective learning (Sya'bania et al., 2020). Animated videos are a crucial tool for educators in visualizing abstract concepts into more concrete and easily digestible representations for students' (Kotimah, 2024). Rapid developments in the fields of computer technology, smartphones and video editing software have made it possible for everyone to produce learning videos independently and with tools that are practical to use (Tambunan et al., 2024).

The execution of animated video-based chemistry learning media can be optimized through live broadcasts using LCD projectors in the classroom or through the use of the YouTube platform (S. W. Putri et al., 2022).

METHODS

This research was conducted at SMA Negeri 11 Medan. It used a quantitative approach with a quasi-experimental approach. The design used was a non-equivalent control group pretest-posttest design, involving two experimental groups without full subject randomization. A pretest and posttest were administered before and after the intervention to evaluate variations in academic achievement arising from the application of distinct pedagogical models. The target population included all Grade X students' from the 2025/2026 academic year. A purposive sampling technique was used to select two classes with an equal distribution of 36 students' each. One class was assigned the Project-Based Learning model, while the other was instructed using the Inquiry-Based Learning approach.

The research utilized a specially developed multiple-choice assessment to evaluate student learning outcomes based on competency achievement indicators in chemical bonding. The test consisted of 20 questions covering students' cognitive aspects. Prior to use, the instrument underwent validity and reliability testing. Validity testing was conducted to determine the appropriateness of the items, while reliability testing ensured the instrument's consistency in measuring learning outcomes. Additionally, an analysis of item difficulty and discrimination indices was performed to guarantee the integrity and caliber of the research instrument.

RESULT AND DISCUSSION

RESULT

Following the research design and data analysis procedures described previously, this section presents the findings of the study, including descriptive statistics, assumption testing (normality and homogeneity), and hypothesis testing.

The research began with the distribution of a pretest to both experimental groups before the learning activities began and a posttest at the end of the lesson to assess the comparative achievement levels within the two classes. The descriptive statistics for student learning outcomes across both experimental groups, derived from pre-test and post-test data, are detailed in the following **Table 1**.

Table 1. Learning Outcome Data for Experimental Classes I and II

Data	N	Minimum	Maximum	Mean
Pretest Experiment I	36	40	70	54.72
Pretest Experiment II	36	35	60	47.50
Posttest Experiment I	36	75	100	88.06
Posttest Experiment II	36	70	95	83.75

Based on Table 1, the average pretest score of Experimental Class I (PjBL) was 54.72, while Experimental Class II (IBL) obtained a lower mean score of 47.50. This indicates that the initial ability of students' in both groups was relatively comparable, although the PjBL group showed slightly higher initial performance.

After the treatment, the posttest results show a notable improvement in both groups. The mean score of the PjBL group increased to 88.06, whereas the IBL group reached 83.75. This finding suggests that both learning models contributed to improving students' learning outcomes; however, the increase in the PjBL group was higher compared to the IBL group.

Before conducting hypothesis testing, a normality test was performed to ensure that the data were normally distributed. The Shapiro–Wilk test was used due to the sample size being less than 50. A significance level of $\alpha = 0.05$ was applied to this test, where the requirement for a normal distribution is a (Sig.) value > α. The specific outcomes of the normality analysis can be found in **Table 2**. below.

Table 2. Results of Shapiro–Wilk Normality Test for Pretest and Posttest Scores

Data	α	Sig.	Information
Pretest Experiment I	0.05	0.128	Normal Distribution
Posttest Experiment I	0.05	0.056	Normal Distribution
Pretest Experiment II	0.05	0.061	Normal Distribution
Posttest Experiment II	0.05	0.051	Normal Distribution

The normality analysis reveals that the learning outcome data for both pre-test and post-test in both experimental classes are normally distributed, with all (Sig.) values > α (0.05).

Then, the analysis of homogeneity of variance was implemented through the Levene test assisted at a significance level of 0.05. According to the established decision-making rules, a significance (Sig.) value is > 0.05, then the data from both sample groups are concluded to originate from a population with homogeneous variance. The homogeneity test results data can be seen in **Table 3.** below.

Table 3. Results of Levene's Test for Homogeneity of Variance

Data	Sig.	α	Information
Pretest Experiment I	0,560	0,05	Homogeneous Data
Pretest Experiment II			
Posttest Experiment I	0,882	0,05	Homogeneous Data
Posttest Experiment II			

Based on the results of the homogeneity test analysis, it was found that the pretest and posttest data on learning outcomes in both experimental classes came from a homogeneous population (Sig. > 0.05).

Once the criteria for normality and homogeneity were satisfied, the Independent Sample t-test was employed for hypothesis testing at a significance level of α = 0.05 with the testing criteria if the Sig. (2-tailed) value < α, then H_0 is rejected meaning H_a is accepted. The results of the hypothesis test can be seen in **Table 4.** below.

Table 4. Hypothesis Test Results

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Learning Outcomes	Equal variances assumed	.022	.882	2.798	70	.007	4.306	1.539	1.237	7.374
	Equal variances not assumed			2.798	69.812	.007	4.306	1.539	1.237	7.374

Based on the results of the second hypothesis test, the Sig. (2-tailed) < α (0.007 < 0.05) which means that H_0 is rejected and H_a is accepted. These findings demonstrate a significant disparity in chemistry learning outcomes between students' instructed through Project-Based Learning and those through Inquiry-Based Learning, both integrated with animated video media for chemical bonding topics.

However, statistical significance alone does not indicate the magnitude of the difference. Therefore, effect size analysis was conducted using Cohen's d. The calculation resulted in an effect size value of 1.01, which falls into the category of a large effect. This finding indicates that the difference between the two groups is not only statistically significant but also practically meaningful. In other words, the Project-Based Learning model has a strong positive impact on improving students' learning outcomes compared to the Inquiry-Based Learning model.

DISCUSSION

Based on the issues related to this research, the theories supporting the research, and the methods used, this chapter will explain the research results. In this study, the learning model used in the two experimental classes differed, but both were supported by animated video media. In experimental class I, learning was implemented using the Project Based Learning model by providing a project in the form of making posters about chemical bonding material. Meanwhile, in experimental class II, which used the Inquiry-Based Learning model, students' were given worksheets containing questions and problems related to chemical bonding. These worksheets were designed to encourage students' to investigate the concepts being learned.

A pretest was administered to both experimental classes as an initial step to determine students' initial abilities. The pretest results obtained in experimental class I (PjBL) were 54.72, while the pretest results for experimental class II (IBL) were 47.50. Subsequently, each class was given a different treatment according to the learning model implemented, following the syntax of each model and supported by the use of animated video media. The learning process was carried out over three sessions, each lasting three lesson hours (135 minutes). Each class was formed into 6 groups and then students' were given worksheets that had been validated by the validator to carry out the practice that had been prepared by the researcher.

Once the learning sessions concluded, a posttest was utilized as a tool to assess the resulting learning outcomes from the implemented model. Based on the results obtained, the posttest learning outcome data were processed and the average score obtained in experimental class I was 88.06, while in experimental class II it was 83.75. The results showed that the PjBL model produced a higher average learning outcome score compared to IBL (Prihatin et al., 2024). This difference is not only statistical but also indicates a difference in the effectiveness of the learning process applied to the two groups.

After obtaining the posttest data, prerequisite tests were conducted to ensure that the data met the assumptions required for parametric analysis. These prerequisite tests included normality and homogeneity testing. Normality testing was carried out using the Shapiro–Wilk test. The results showed that the significance (Sig.) value for Experimental Class I was 0.128, while Experimental Class II obtained a value of 0.056. Given that both values exceed the 0.05 threshold, it is concluded that the posttest data for both groups follow a normal distribution. Therefore, the assumption of normality has been satisfied.

Furthermore, a homogeneity test was conducted using Levene's test to examine the equality of variances between the two groups. The result indicated a significance (Sig.) value of 0.312, which is higher than 0.05. This finding confirms that the variances of the two groups are homogeneous, meaning that the homogeneity assumption has also been fulfilled.

After meeting both assumptions, hypothesis testing was performed using an Independent Sample t-test. The results revealed a significance value (Sig. 2-tailed) of 0.007 ($p < 0.05$), indicating that there is a statistically significant difference in students' learning outcomes between those taught using the Project-Based Learning (PjBL) model and those taught using the Inquiry-Based Learning (IBL) model.

These findings suggest that the learning models implemented have different effects on students' learning outcomes. More specifically, the results indicate that the Project-Based Learning (PjBL) model is more effective in improving students' learning outcomes compared to the Inquiry-Based Learning (IBL) model, particularly in the context of chemical bonding material.

The evidence obtained corroborates earlier literature regarding the comparative effectiveness of PjBL and Inquiry-Based models. The data indicates that PjBL yields higher improvements in student outcomes, supported by a calculated t-value (9.67) that is significantly greater than the critical t-table value (1.667) (Johana et al., 2023).

Several previous studies have confirmed that the Project-Based Learning (PjBL) model provides opportunities for students' to work collaboratively in groups (Mona et al., 2023). Through collaborative activities, students' can exchange ideas, provide feedback, and learn from diverse perspectives. This process not only contributes to improving social skills but also deepens student's understanding because they are required to express ideas and consider others perspectives (Putri et al., 2025). In addition, the implementation of Project-Based Learning enhances student engagement throughout the instructional period, which subsequently leads to superior academic performance (Setiawati et al., 2024). This is because the PjBL model is a learning model that focuses on the fundamental concepts and principles of a scientific discipline, engages students' in problem solving and other meaningful tasks, provides them with the opportunity to work independently to build their own learning, and produces student-produced work (Fahadah et al., 2021). This is in line with the constructivist approach which emphasizes that knowledge is actively constructed by students' through learning experiences (Abri et al., 2024). In this context, the use of animated video media plays a supporting role in helping to visualize microscopic concepts, thereby reducing cognitive load and improving students' understanding of concepts (Dheadema et al., 2023).

On the other hand, although the Inquiry-Based Learning (IBL) model also showed improved learning outcomes, its effectiveness was relatively lower than that of PjBL. This may be due to the cognitive demands of the inquiry model, which requires students' to independently formulate problems, formulate hypotheses, and conduct investigations, thus requiring a higher level of learning readiness. Research on the implementation of the Inquiry-Based Learning model also shows that it is effective in stimulating the development of critical reasoning and conceptual understanding in students' when implemented optimally (Sari et al., 2026). However, the effectiveness of this model is also greatly influenced by learning conditions such as student readiness, learning time, and student concentration levels during the learning process (Hidayatullah & Widhyastuti, 2025).

Differences in the time of implementation of learning are also thought to influence the results obtained (Andriansah & Irianto, 2024). Classes implementing the IBL model are held during the day, while PjBL classes are held in the morning. This situation has the potential to impact students' concentration levels and readiness to learn, as afternoon lessons tend to be accompanied by greater physical fatigue, which can impact the learning process less than optimally (Heemskerk et al., 2022).

However, these results also show that the effectiveness of a learning model is not only determined by the characteristics of the model itself, but is also influenced by external factors such as learning conditions, implementation time, and student readiness (Amalia et al., 2022). Besides that, it also examines how animated video media is integrated into the learning process. In the PjBL model, the use of animated video tends to be more optimal because it supports contextual and collaborative project activities. Conversely, in the IBL model, although animated video aids in presenting concepts, its utilization is less optimal because the learning process emphasizes students' independent exploration.

From this description, it is clear that the learning model significantly influences student learning outcomes. Learning models that connect learning material to everyday life, such as undertaking a project, can foster student enthusiasm for learning. This is why student learning outcomes in PjBL classes are higher than in inquiry classes.

CONCLUSION

There is a difference in the learning outcomes of students' who are taught using the Project Based Learning model and Inquiry Based Learning assisted by animated videos on chemical bonding material. This can be seen from the average learning outcomes of students' taught with the Project Based Learning model of 88,06 which is higher than the Inquiry Based Learning model of 83,75 and the results of the t-test which shows a Sig. (2-tailed) < α (0.007 < 0.05) which means that H_0 is rejected and H_a is accepted. These findings not only demonstrate statistical differences but also confirm that learning effectiveness is influenced by the integration between the learning model and the media used. In this case, animated video media acts as a tool to help visualize abstract concepts, and its utilization is more optimal when integrated into structured learning stages such as in the PjBL model.

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REFERENCE

Abri, M. H. Al, Aamri, A. Y. Al, & Elhaj, A. M. A. (2024). Enhancing Student Learning Experiences Through Integrated Constructivist Pedagogical Models. *European Journal of Contemporary Education and E-Learning*, *2*(1), 130–149. https://doi.org/10.59324/ejceel.2024.2(1).11

Amalia, A., Sucipto, & Hilyana, F. S. (2022). Konsentrasi Belajar Siswa Pada Mata Pelajaran IPA. *Jurnal Educatio*, *8*(4), 1261–1268. https://doi.org/10.31949/educatio.v8i4.3120

Andriansah, R., & Irianto, D. (2024). Pengaruh Durasi Pembelajaran Terhadap Sikap dan Hasil Belajar Siswa pada Mata Pelajaran Estimasi Biaya Konstruksi. *Jurnal Kajian Pendidikan Teknik Bangunan (JKPTB)*, *10*(1), 78–84. https://doi.org/https://doi.org/10.26740/jkptb.v10i1.61533

Anggraini, P. D., & Wulandari, S. S. (2020). Analisis Penggunaan Model Pembelajaran Project Based Learning Dalam Peningkatan Keaktifan Siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(2), 292–299. https://doi.org/10.26740/jpap.v9n2.p292-299

Artawan, P. G. O., Kusmariyatni, N., & Sudana, D. N. (2020). Pengaruh Model Pembelajaran Discovery Learning Terhadap Hasil Belajar IPA. *Jurnal Ilmiah Pendidikan Profesi Guru*, *3*(3), 452. https://doi.org/10.23887/jippg.v3i3.29456

Dheadema, S. A., Muharini, R., Rasmawan, R., Enawaty, E., & Lestari, I. (2023).

Jurnal Inovasi Pendidikan Kimia Video Animasi Sebagai Media Pembelajaran pada Materi Hidrokarbon. *Jurnal Inovasi Pendidikan Kimia*, *17*(2).

Fahadah, S. E., Lutfiya, F., Universitas, P., & Semarang, N. (2021). Penerapan PjBL (Project Based Learning) Daring untuk Meningkatkan Hasil Belajar Siswa di Masa Pandemi Covid-19. *Jurnal Profesi Keguruan*, *7*(2), 198–208.

Hanafiah, & Suhana. (2012). *Konsep Strategi Pembelajaran*. Bandung: PT Refika Aditama.

Heemskerk, C., Lars-, S. S., & Malmberg, E. (2022). Physical activity predicts task- - related behaviour , affect and tiredness in the primary school classroom : A within- - person experiment. *British Journal of Educational Psychology*, 1–22. https://doi.org/10.1111/bjep.12523

Hidayatullah, M. I., & Widhyastuti, K. L. (2025). Efektifitas Penggunaan Model Pembelajaran Inquiry dalam Pembelajaran IPA di Sekolah Dasar Literature Review : Effectiveness of Using Inquiry Learning Model in Science Learning in Elementary Schools. *IJoEd : Indonesian Journal on Education Tinjauan Literatur :*, *1*(3), 228–234.

Hulu, P., Harefa, A. O., & Mendrofa, R. N. (2023). Studi Model Pembelajaran Inkuiri terhadap Pemahaman Konsep Matematika Siswa. *Educativo: Jurnal Pendidikan*, *2*(1), 152–159. https://doi.org/10.56248/educativo.v2i1.97

Ibrahim, T. A., & Sutiani, A. (2025). Development of a Chemistry E-module with a STEM-Integrated Project Based Learning Model on Chemical Equilibrium Material. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *7*(2), 226–234.

Ismuwardani, Z., Nuryatin, A., & Doyin, M. (2019). Implementation of Project Based Learning Model to Increased Creativity and Self-Reliance of Students' on Poetry Writing Skills. *Journal of Primary Education*, *8*(1), 51–58. https://journal.unnes.ac.id/sju/index.php/jpe/article/view/25229

Johana, N. R., Purwoko, A. A., Hadisaputra, S., & Kimia, P. (2023). Efektivitas Model Project Based Learning dan Model Inkuiri dalam Memperbaiki Hasil Belajar Kimia. *Jurnal Teknologi Pendidikan*, *8*(2), 287–295. https://doi.org/https://dx.doi.org/10.33394/jtp.v8i2.6389

Kotimah, E. K. (2024). Meningkatkan pendidikan sains menjelajahi dampak video animasi powtoon dalam instruksi IPA. *Katera: Jurnal Sains Dan Teknologi*, *1*(1), 5–12. https://journal.lintasgenerasi.com/index.php/katera/article/view/26

Lestari, T. D., Mayasari, D., & Untajana, J. R. (2023). Upaya meningkatkan hasil belajar siswa melalui penerapan model pembelajaran discovery learning. *Journal of Didactic Mathematics*, *4*(1), 36–42. https://doi.org/10.34007/jdm.v4i1.1721

Lovisia, E. (2018). Pengaruh Model Pembelajaran Inkuiri Terbimbing terhadap Hasil Belajar. *Science and Physics Education Journal (SPEJ)*, *2*(1), 1–10. https://doi.org/10.31539/spej.v2i1.333

Mauk, F. K., Komisia, F., & Tukan, M. B. (2022). Perbandingan Hasil Belajar Yang Menerapkan Model Pembelajaran Berbasis Masalah Dan Inkuiri Terbimbing. *Educativo: Jurnal Pendidikan*, *1*(2), 465–472. https://doi.org/10.56248/educativo.v1i2.66

Mona, N., Rachmawati, R. C., & Anshori, M. (2023). Penerapan Model Project

Based Learning untuk Meningkatkan Keterampilan Kolaborasi dan Kreativitas Peserta Didik. *Jurnal Pendidikan Guru Profesional*, *1*(2), 150–167.

Muliaman, A. (2021). Efektivitas Model Project Based Learning Berorientasi eXe Learning dan Motivasi terhadap Hasil Belajar pada Materi Laju Reaksi. *Jurnal Ilmu Pendidikan (JIP) STKIP Kusuma Negara*, *13(1)*, 51–57. https://doi.org/https://dx.doi.org/10.37640/jip.v13i1.956

Namira, & Kweldju, A. De. (2022). Pengaruh Model Pembelajaran Inquiry Based Learning Terhadap Hasil Belajar Kognitif Siswa Kelas X Ipa Sma Negeri 02 Manokwari Pada Materi Pokok Ikatan Kimia. *Arfak Chem: Chemistry Education Journal*, *5*(2), 446–454. https://doi.org/10.30862/accej.v5i2.350

Nirmayani, L. H., Putu, N., & Prastya, C. (2021). Model Pembelajaran Berbasis Proyek (Project Based Learning) Sesuai Pembelajaran Abad 21 Bermuatan Tri Kaya Parisudha. *Jurnal Pedagogi Dan Pembelajaran*, *4*(3), 378–385. https://doi.org/https://doi.org/10.23887/jp2.v4i3.39891

Oktiani, I. (2017). Kreativitas Guru dalam Meningkatkan Motivasi Belajar Peserta Didik. *Jurnal Kependidikan*, *5*(2), 216–232. https://doi.org/10.24090/jk.v5i2.1939

Panggabean, F. T. M., Silitonga, P. M., & Purba, J. (2023). Analysis Student Motivation and Learning Outcomes by Apllying Problem Based Learning and Discovery Learning Models. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *5*(1), 11–16.

Panggabean, F. T. M., Sutiani, A., & Purba, J. (2024). Development of IBL STEM Model-Based Teaching Materials Using Wordwall to Improve Students' ' Critical Thinking Skills. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *6*(2), 285–296.

Perangin Angin, C. K., & Juwitaningsih, T. (2023). Pengaruh Penerapan Model Pembelajaran PjBL Berbantuan Media Digital Flipbook Terhadap Minat dan Hasil Belajar Siswa. *Jurnal Pendidikan Sosial Dan Humaniora*, *2*(1), 306–316.

Prasetiyo, M. B., & Rosy, B. (2020). Model Pembelajaran Inkuiri Sebagai Strategi Mengembangkan Kemampuan Berpikir Kritis Siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(1), 109–120. https://doi.org/10.26740/jpap.v9n1.p109-120

Prihatin, R., Sukmawati, F., Cahyono, B. T., & Santosa, E. B. (2024). The Effect of PJBL and IBL on the Learning Independence of Vocational School Students'. *Interdisciplinary Journal of Islamic Education*, *5*(4), 598–611. https://doi.org/https://doi.org/10.31538/tijie.v5i4.1171

Priliyanti, A., Muderawan, I. W., & Maryam, S. (2021). Analisis Kesulitan Belajar Siswa Dalam Mempelajari Kimia Kelas Xi. *Jurnal Pendidikan Kimia Undiksha*, *5*(1), 11–18. https://doi.org/10.23887/jjpk.v5i1.32402

Putri, N. M., Hakim, L. El, & Ristanto, R. H. (2025). Studi Literatur Penerapan Project-Based Learning (PjBL) pada Pembelajaran Kimia. *Ideguru: Jurnal Karya Ilmiah Guru*, *10*(1), 433–442. https://doi.org/https://doi.org/10.51169/ideguru.v10i1.1251

Putri, S. W., Taufik, L., & Qurniati, D. (2022). Pengembangan Media Pembelajaran Kimia Berbasis Video Animasi Untuk Meningkatkan Motivasi Belajar Siswa SMAN 1 WANASABA. *SPIN: Jurnal Kimia & Pendidikan Kimia*, *4*(100), 58–66. https://doi.org/10.20414/spin.v4i1.5092

Ramdhani, E. P., Khoirunnisa, F., & Siregar, N. A. N. (2020). Efektifitas Modul Elektronik Terintegrasi Multiple Representation pada Materi Ikatan Kimia. *Journal of Research and Technology*, *6*(1), 162–167. https://doi.org/https://doi.org/10.55732/jrt.v6i1.152

Ritonga, P. I. Ab., & Gumolung, D. (2021). Pengaruh Penggunaan Simulasi Virtual Laboratorium PhET (Physics Education Technology) Terhadap Hasil Belajar Siswa Pada Materi Geometri Molekul di MAN 1 Bitung. *Oxygenius Journal Of Chemistry Education*, *3*(2), 81–87. https://doi.org/10.37033/ojce.v3i2.288

Sari, S., Hidayat, H., & Martha, A. (2026). Pengaruh Model Inquiry Based Learning Terhadap Pemahaman Pembelajaran Ipa Di Gugus Vi Kecamatan Palembayan. *Al-Madrasah : Jurnal Ilmiah Pendidikan Madrasah Ibtidaiyah*, *10*(1), 350–362. https://doi.org/10.35931/am.v10i1.5809

Setiawati, D. T., Halimah, S., & Budiyanti, Y. (2024). Pengaruh Model Pembelajaran Project Based Learning Dan Minat Belajar Terhadap Hasil Belajar Pai. *Research and Development Journal Of Education*, *10*(1), 169–177.

Silitonga, P. M., Panggabean, F. T. M., & Susanti, N. (2022). Hubungan Kemampuan Matematika dan Kemampuan Awal dengan Hasil Belajar Kimia Siswa pada Materi Larutan Penyangga. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(2), 132–138.

Sukmawati, T. (2020). Upaya Meningkatkan Aktivitas Dan Hasil Belajar Kimia Pada Ma-teri Kesetimbangan Kimia Melalui Penerapan Model Pembelajaran Inquiry Based Learning (IBL) siswa kelas XI-IA 5 SMA Negeri 4 Banda Aceh. *Jurnal Pendidikan Dan Pengabdian Vokasi (JP2V)*, *1*(3), 307–315. https://doi.org/10.32672/jp2v.v1i3.2295

Susanti, N., Latuconsina, A., Asshagab, S. M., & Mursalin, E. (2023). Pengaruh Penggunaan Media Video Animasi Pembelajaran IPA Terhadap Hasil Belajar Kognitif Siswa Kelas VIII SMPN 14 Ambon. *Al-Alam: Islamic Natural Science Education Journal*, *2*(1), 28–38. https://doi.org/10.33477/al-alam.v2i1.4293

Susanti, N., Simatupang, L., Dibyantini, R. E., Andi, R., & Ginting, E. (2022). Hubungan Self-Efficacy dan Kemampuan Berpikir Kreatif dengan. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *4*(2), 202–208.

Susanty, H. (2022). Problematika Pembelajaran Kimia Peserta Didik Pada Pemahaman Konsep Dan Penyelesaian Soal Soal Hitungan. *Al Qalam: Jurnal Ilmiah Keagamaan Dan Kemasyarakatan*, *16*(6), 1929. https://doi.org/10.35931/aq.v16i6.1278

Sya'bania, N., Anwar, M., & Wijaya, M. (2020). Pengembangan Media Pembelajaran Berbasis Video Animasi dengan Model Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Motivasi dan Hasil Belajar Peserta Didik. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699. https://doi.org/https://doi.org/10.26858/cer.v4i1.13315

Tambunan, S. M., Purba, J., & Panggabean, F. T. M. (2024). The Influence of Problem Based Learning and Media to Increase Student Interest and Learning

Outcomes. *Jurnal Inovasi Pembelajaran Kimia (Journal Of Innovation in Chemistry Education)*, *6*(1), 120–129.

Tintingon, J. Y., Lumapow, H. R., & Rotty, V. N. J. (2023). Problematika dan Perubahan Kebijakan Pendidikan di Indonesia. *Jurnal Educatio FKIP UNMA*, *9*(2), 798–809. https://doi.org/10.31949/educatio.v9i2.5088

Togatorop, A., & Kumajas, J. (2023). *Efektivitas Tes Diagnosis Multiple Intellegence Terhadap Hasil Belajar Siswa Pada Materi Ikatan Kimia Di SMA Negeri 1 Tondano*. *5*(1), 20–25. https://doi.org/10.37033/ojce.v4i2.523