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Research Article

The Effect of Discovery Learning Model Integrated with Javalab Simulation On Students' Conceptual Understanding and Learning Interest in Chemical Bonding Material

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ABSTRACT

Students often experience difficulties in understanding chemical concepts, which are generally abstract, such as chemical bonding material. The primary objective of the current research is to ascertain the specific impact resulting from the adoption of the Discovery Learning framework integrated with Javalab simulation of students' conceptual understanding as well as their interest in learning chemical bonding material within SMA Negeri 2 Sawang. The investigative approach employed was a Pre-Experimental methodology that specifically adopted an Intact Group Comparison design structure. The entire population involved in this academic study comprised every student currently enrolled in class XI SMA Negeri 2 Sawang, with the sample determined by Saturated Sampling, consisting of class XI-1 as the treatment group and class XI-2 as the comparison group. The techniques utilized for the collection of necessary data included test instruments (posttest) to measure concept understanding and questionnaires to measure student motivation toward their studies. The purpose of analyzing used the Independent Sample T-test. The findings demonstrated that there was a meaningful impact existed from the Discovery Learning approach integrated with Javalab simulation on students' concept understanding (Sig. 2-tailed 0.002 < 0.05) and their educational curiosity (Sig. 2-tailed 0.000 < 0.05). The application of this model can visualize abstract concepts while simultaneously increasing the level of student involvement throughout the entire learning process.

Keywords: Discovery Learning; Javalab Simulation; Conceptual Understanding; Learning Interest; Chemical Bonding

1. INTRODUCTION

Education in the 21st century demands a transformation in the learning process, where students are no longer just passive objects but active subjects capable of critical thinking and problem-solving. The Kurikulum Merdeka (Independent Curriculum) currently applied emphasizes student-centered learning to develop their potential to the fullest (Kemendikbud, 2020). The overarching objective of national education is to intellectually enrich the life of the nation while simultaneously fostering the development of the Indonesian individual in a holistic and complete manner. Therefore, teachers are required to innovate in selecting instructional models and media that are relevant to the times, one of which is through the the strategic incorporation of technology in science education (Rahman et al., 2022). However, the reality in the field shows a gap between expectations and reality. Based on initial observations and interviews at SMA Negeri 2 Sawang, it was found that the subject of chemistry continues to be regarded as arduous and frightening for most students. The difficulty in learning chemistry is often caused by the characteristics of chemistry itself, where most concepts are abstract and complex (Sariati et al., 2020; Nusi et al., 2021). Many students demonstrate a lack of engagement during the instructional process, tend to be silent when asked, and have difficulty understanding chemical concepts, which consequently leads to poor academic performance that falls beneath the standard Minimum Completeness Criteria (KKM).

Chemical Bonding material is one of the essential materials in grade 11 that is full of abstract concepts, such as the formation of ionic, covalent, and metallic bonds, as well as interactions between particles that cannot be observed directly with the naked eye (Putra & Kartini, 2020; Sariwati et al., 2023). Conventional learning that relies only on the lecture method (Direct Instruction) often fails to visualize these microscopic processes (Fahkrah et al., 2017). As a result, students only memorize theories without truly understanding the formation mechanisms, which ultimately lowers their learning interest in the material. Low learning interest is a serious problem because interest is an important factor influencing student learning success (Apriyani et al., 2022; Hidayati, 2022).

As a solution to these problems, the application of the Discovery Learning model integrated with digital simulation technology becomes a promising alternative. The Discovery Learning framework guides students to discover chemical concepts on their own via a sequence ofscientific stages, which is proven to increase student activity and learning outcomes (Wulan et al., 2021; Rahmayani, 2019; Pangesti & Radia, 2021). To support this discovery process, Javalab simulation media is used as a visualization tool. Javalab provides a digital environment where students to manipulate variables and observe chemical phenomena virtually, making learning more interactive (Mashita et al., 2024; Tambunan & Sinaga, 2025). Several previous studies have examined the effectiveness of active learning models. For example, Sariwati et al. (2023) found that the Discovery Learning model significantly improved student learning outcomes in chemical bonding. Furthermore, the use of visualization technologies such as digital simulations has also proven vital; Mashita et al. (2024) highlighted that Javalab is capable of transforming abstract, submicroscopic visualizations into concrete concepts.

However, there are still limitations in the existing literature. Most studies tend to focus on only one variable, either the model or the media, or measure only cognitive aspects. Few studies have specifically integrated Discovery Learning syntax with Javalab simulations to simultaneously measure their impact on students' understanding of complex concepts and learning interest in Chemical Bonding. This study aims to fill this gap by offering an integrated approach that emphasizes not only conceptual discovery (cognitive) but also student emotional engagement (affective) through interactive visualization. The primary objective of this current research endeavor is to evaluate the overall efficacy of combining a Discovery Learning pedagogical assisted by Javalab simulation in improving the quality of chemistry instruction. The main focus of the inquiry is to see its influence on two important variables, namely students' conceptual understanding in the cognitive domain and students' learning interest in the affective domain. The originality of this research is situated in the use of Javalab combined with the Discovery Learning syntax for Chemical Bonding material, which is expected to create an active learning atmosphere and foster students' curiosity (Harisandi, 2020; Simbolon et al. (2021)).

2. RESEARCH METHOD

This methodology employed throughout this investigation is fundamentally quantitative in nature, specifically utilizing a Pre-Experimental Design framework. The specific research design applied is Intact Group Comparison, where one class group is used as the experimental unit while another separate class group functions as the control counterpart. This investigation was carried out at the institution of SMA Negeri 2 Sawang, located within the North Aceh Regency, during the course of the odd semester for the 2025/2026 Academic Year. The target population for this research includes entirety of the 11th-grade science students (Class XI IPA) at SMA Negeri 2 Sawang consisting of two specific sections, namely XI-1 and XI-2, amounting to a grand total of 41 learners. The sampling technique used was Saturation Sampling (census), which implies that every single member of the population was utilized as a research samples. Class XI-1 with 21 students was designated as the experimental class receiving the Discovery Learning model treatment integrated with Javalab simulation, while class XI-2 with 20 students was designated as the control class taught with the direct learning model (Direct Instruction).

Table 1. Intact Group Comparison research design

Subjects	Treatment	Postest
Experiment	X	O1
Control	-	O2
Subject	Treatment	Postest

Source: (Sugiyono, 2022)

The variables examined within this research framework are comprised of both independent variables as well as dependent variables. Specifically, the independent variable employed is the Discovery Learning model assisted by Javalab simulation media, while the dependent variables are students' grasp of concepts and their interest in learning regarding the subject of Chemical Bonding. The research procedure began with the preparation stage, continued with the implementation stage (treatment), and ended with evaluation. In the experimental class, students used Javalab simulations to visualize the formation of chemical bonds, in line with the approach taken by Mashita et al. (2024).

Table 2. Product Moment Correlation Coefficient Criteria

No	Correlation Coefficient	Category
1	$0{,}80 \le rxy \le 1{,}00$	Very high
2	$0{,}60 \le rxy \le 0{,}80$	High
3	$0{,}40 \le rxy \le 0{,}60$	Medium
4	$0{,}20 \le rxy \le 0{,}40$	Low
5	$0{,}00 \le rxy \le 0{,}20$	Very low

Source: (Arikunto, 2017)

Data collection instruments used consisted of two types, namely tests and non-tests. To measure conceptual understanding a written examination featuring multiple-choice questions was administered, given at the end of learning (post-test). Meanwhile, to measure learning interest, a questionnaire with a Likert scale was used covering indicators of pleasure, interest, involvement, and student attention (Sinaga & Yunilisa, 2024; Chandra et al., 2023). Before being used, both instruments were required to pass assessments concerning their validity, reliability, level of difficulty, and power of discrimination. The techniques for analyzing the data were executed with the assistance provided by the SPSS software, specifically version 25 software. The analysis steps began with prerequisite tests, specifically the normality test utilizing the Shapiro-Wilk method as well as the test for homogeneity of variance utilizing the Levene Statistic (Rahayu & Pujiastuti, 2018). After the prerequisites were met, the testing of the hypothesis was conducted through the utilization of the Independent Sample t-test. The decision-making criterion is if the significance value (Sig. 2-tailed) < 0.05, then the null hypothesis (Ho) is rejected, which means there is a significant influence from the treatment given.

3. RESULTS AND DISCUSSION

3.1 Research Results

The data obtained during the course of this research project include instrument trial data, posttest scores for concept understanding, and student learning interest questionnaire scores.

3.1.1 Research Instrument Analysis

Before the instruments were used, validity and reliability tests were conducted. From the 26 questions tested, 13 valid and reliable questions were obtained for use as the research measurement tool.

Table 3. Recap of Test Instrument Validity and Reliability Results

Category	Number of Questions	Description	Reliability (r_{11})
Valid	13	Used for Posttest	0.86 (Very High)
Invalid	13	Discarded	-

3.1.2 Description of Concept Understanding Data

Following the administration of the posttest conducted after the treatment, data on the students' aptitude for understanding concepts principles within both the treatment group and the comparison group classes were obtained. The descriptive statistics summary can be found detailed within **Table 4**.

Table 4. Statistical Data of Concept Understanding Posttest Results

Statistics	Experimental Class	Control Class
Number of Students (N)	21	20
Highest Score	92	77
Lowest Score	54	38
Mean	70.05	57.33
Standard Deviation	12.45	11.82

Table 3 shows that the experimental class demonstrated a higher average score for concept understanding than the control class, revealing a mean difference of 12.72 points.

3.2 Discussion

3.2.1 The Effect of Discovery Learning Integrated with Javalab on Concept Understanding

Based on the findings, it is evident that implementing the Discovery Learning instructional model integrated with Javalab simulation had a beneficial impact on students' concept understanding of chemical bonding material. This is evidenced by an average post-test score of 70.05 in the experimental class, which is significantly superior to the score of 57.33 recorded by the control group. This success is inseparable from the syntax stages of Discovery Learning which guide students to discover concepts independently. The stimulation and problem statement stages trigger students' curiosity, while data collection and data processing assisted by Javalab allow students to visualize the abstract process of chemical bond formation. The significant increase in conceptual understanding indicates that the integration of Javalab in Discovery Learning effectively bridges the abstractness of the material. This finding aligns with the research of Andrawati et al. (2023) which states that Discovery Learning facilitates independent knowledge construction. Furthermore, these results support the study by Sariwati et al. (2023), which found that the application of the Discovery Learning model specifically on chemical bonding material was able to significantly improve student learning outcomes compared to conventional methods. The difference in this study lies in the presence of Javalab as a visualization aid. This finding effectively answers the problems identified by Sariati et al. (2020), who noted that students often experience difficulties in learning chemistry due to the abstract nature of the concepts and the lack of connection between macroscopic and submicroscopic levels. This study proves that visualization assistance from Javalab makes the process of 'data collection' and 'proof' in DL syntax more accurate. This differs from conventional learning or DL without media, where students often have difficulty imagining the movement of electrons in ionic and covalent bonds (Nurillah et al., 2023). Javalab simulations play a crucial role in transforming microscopic representations of atoms into visuals observable by students. As stated by Mashita et al. (2024), the use of Javalab helps students connect three distinct levels of chemical representation: the macroscopic, the submicroscopic, and the symbolic levels. Additionally, Wahyuni et al. (2024) also confirmed that Discovery Learning encourages students to be more active in building their own understanding, which is crucial for mastering complex concepts like chemical bonding. This visualization reduces students' cognitive load in imagining electron movement during ionic or covalent bond formation, making concept retention stronger compared to lecture methods alone.

3.2.2 The Effect of Discovery Learning Integrated with Javalab on Learning Interest

In addition to the cognitive aspect, this study also confirmed a significant improvement in the affective aspect. The interest in learning demonstrated by students within the experimental group was classified as "Very High". The use of technology-based media such as Javalab simulations proved effective in capturing student attention and maintaining learning relevance. Students felt happier and actively involved because they not only listened but also interacted directly with the simulation to prove their hypotheses. These results are consistent with the findings of Simbolon et al. (2021), who argued that interactive education based on discovery has the capacity to boost students' intrinsic motivation, make the classroom atmosphere more lively, and reduce learning boredom. This finding is also in line with Zain (2023), who stated that the application of Discovery Learning can stimulate interaction between students and teachers, thereby increasing students' interest in learning materials that were previously considered difficult, such as nanotechnology or chemical bonding. On terms of affective aspects, the high level of student learning interest (category: Very High) supports the results of Cahyana et al. (2017) regarding the positive impact of technology-based media on motivation. Similarly, Adima et al. (2024) found that the use of simulation media in learning science significantly helps increase student motivation because abstract concepts become more concrete and easier to imagine. A specific advantage of this study is the interactivity of Javalab, which allows students to directly manipulate the binding variables. This provides a virtual 'hands-on' experience not found in static image or passive video media, thus effectively minimizing boredom. This is also supported by Harisandi (2020), who found that the use of aids or media in Discovery Learning is proven to increase student learning motivation significantly compared to learning that only relies on textbooks.

4. CONCLUSION

Drawing from the comprehensive evaluation of the gathered data and the subsequent thematic discourse, the following primary conclusions have been established: (1) The implementation effect of the Discovery Learning learning model integrated with Javalab simulation on students' concept understanding of chemical bonding material at SMA Negeri 2 Sawang, indicated by a Sig. value of $0.002 < 0.05$; (2) Furthermore, this specific pedagogical approach demonstrates a profoundly positive influence on the overall academic engagement and curiosity of the learners, indicated by a Sig. value of $0.000 < 0.05$. The implication of this study suggests that chemistry teachers should optimize the utilization of digital simulation media when teaching abstract materials to enhance the overall quality of educational outcomes and student motivation.

REFERENCES

Andrawati, B. S., Isa, I., & Laliyo, L. A. R. (2023). Pengaruh Model Pembelajaran Discovery Learning Terhadap Pemahaman Konsep Pada Materi Termokimia. Jurnal Pendidikan Kimia Undiksha, 7(1), 23–28. https://doi.org/10.23887/jjpk.v7i1.59726

Annafy, N., Perkasa, M., Agustina, S., Mutmainnah, P. A., & Sari, E. P. (2021). Pengaruh Model Pembelajaran Inquiry Terbimbing Terhadap Pemahaman Konsep Kimia. Jurnal Redoks, 4(1), 17–24. https://doi.org/10.33627/re.v4i1.542

Apriani, R., Harun, A. I., et al. (2021). The effect of PhET simulation on students' understanding of molecular shape. Journal of Physics: Conference Series, 1957(1). https://doi.org/10.1088/1742-6596/1957/1/012007

Aprilia, N. L., & Lutfi, A. (2023). Ethnoscience-based interactive multimedia to improve scientific literacy in chemical equilibrium materials. Hydrogen: Jurnal Kependidikan Kimia, 11(3), 242-252. https://doi.org/10.33394/hjkk.v11i3.7942

Apriyani, R., Nugraha, U., & Yuliawan, E. (2022). Minat Siswa Terhadap Mata Pelajaran Pendidikan Jasmani Kelas X.

Journal of Sport, 6(1), 38–44. https://doi.org/10.37058/sport.v6i1.5022

Cahyana, U., Paristiowati, M., & Fauziyah, S. (2017). Studi Tentang Motivasi Belajar Siswa pada Penggunaan Mobile Game Base Learning dalam Pembelajaran Laju Reaksi Kimia. JRPK: Jurnal Riset Pendidikan Kimia, 7(2). https://doi.org/10.21009/jtp.v19i2.6323

Chandra, M. P., Rasimin, & Lubis, M. A. (2023). Upaya Meningkatkan Minat Belajar Siswa dengan Penerapan Layanan Informasi Menggunakan Media Audio Visual. Jurnal Wahana Konseling, 6(2), 109–119. https://doi.org/10.31851/juang.v6i2.13191

Erika, F., Aksha, O., et al. (2023). Game-Based Learning Media to Improve Students' Understanding in Chemistry Learning. Hydrogen: Jurnal Kependidikan Kimia, 11(3), 233-241. https://doi.org/10.33394/hjkk.v11i3.7922

Harisandi, Y. (2020). Penerapan Model Pembelajaran Discovery Learning Berbantuan Media Plastisin Untuk Meningkatkan Motivasi Belajar. Arfak Chem: Chemistry Education Journal, 3(2), 227–240. https://doi.org/10.30862/accej.v3i2.306

Hayati, R. (2019). Penerapan Model Pembelajaran Discovery Learning untuk Meningkatkan Hasil Belajar Kimia Pada Materi Ikatan Kimia. Arfak Chem: Chemistry Education Journal, 2(2), 148–154. https://doi.org/10.30862/accej.v2i2.290

Hidayati, S. A., Sudarti, S., & Handayani, R. A. D. (2022). Pengaruh Kemampuan Literasi Sains terhadap Minat Belajar Materi Pewarisan Sifat. Jurnal Pendidikan MIPA, 12(4), 1210–1216. https://doi.org/10.37630/jpm.v12i4.766

Hilmi, N., Harjono, A., & Soeprianto. (2017). Pengaruh Model Pembelajaran Discovery dengan Pendekatan Saintifik dan Keterampilan Proses Terhadap Hasil Belajar Fisika. Jurnal Pendidikan Fisika, 4(2). https://doi.org/10.24042/ijsme.v4i2.9017

Hulyadi, H., Muhali, M., & Fibonacci, A. (2023). Identification of Student Conceptions on the Molecular Structure of Organic Compounds Using Question. Hydrogen: Jurnal Kependidikan Kimia, 11(3), 328-338. https://doi.org/10.33394/hjkk.v11i3.8135

Kalsum, U., Saefuddin, M., & Marhadi, A. (2019). Penerapan Model Discovery Learning Berbasis Multirepresentasi Untuk Meningkatkan Keterampilan Berpikir Kritis. Jurnal Pendidikan Kimia Universitas Halu Oleo, 4(2). https://doi.org/10.36709/jpkim.v4i2.8335

Maida, M. C., Bayharti, & Andromeda. (2019). Pengaruh Penggunaan Lembar Kerja Siswa (LKS) Eksperimen Laju Reaksi Berbasis Inkuiri Terbimbing terhadap Hasil Belajar. Jurnal Riset Pendidikan Kimia, 9(1). Https://doi.org/10.21839/jaar.2018.v3is1.165

Manurung, A., Panjaitan, M. B., & Thesalonika, E. (2022). Analysis of Students' Critical Thinking Skills on Learning Outcomes. Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 6(5), 3901–3910. https://doi.org/10.31004/obsesi.v6i5.1886

Mashita, H., Martini, M., & Mahdiannur, M. A. (2024). Analisis Keterlaksanaan Dan Aktivitas Belajar Peserta Didik Menggunakan Model Pembelajaran Inquiry Cycle Berbantuan Javalab. JPF (Jurnal Pendidikan Fisika), 12(1), 1–11. https://doi.org/10.24252/jpf.v12i1.40362

Mawarni, H., Sholahuddin, A., & Badruzsaufari, B. (2022). Validity of Interactive Science Learning Modules to Improve Creative Thinking Skills. Journal of Physics: Conference Series, 1957. https://doi.org/10.1088/17426596/1957/1/012007

Muliaman, A., Unaida, R., & Simanullang, P. A. A. (2022). Pengaruh Model Contextual Teaching and Learning (CTL) Terhadap Hasil Belajar dan Efikasi Diri. Jurnal Ilmiah Wahana Pendidikan, 8(11), 180–187. https://doi.org/10.5281/zenodo.6831321

Muttakin, M., Dewi, U. M., et al. (2022). Penerapan Media Word Square Pada Materi Struktur Atom Untuk Meningkatkan Hasil Belajar Siswa. Relativitas: Jurnal Riset Inovasi Pembelajaran Fisika, 5(2), 85–91. https://doi.org/10.32734/st.v2i1.336

Nasution, H. A., Riswana, S. N., & Kurniawan, E. D. A. (2025). Macromedia Flash 8: Learning Media to Enhance Students' Understanding of Chemical Bonding. J-PEK (Jurnal Pembelajaran Kimia), 10(1), 38-46. https://doi.org/10.17977/um026v10i12025p38

Nurillah, H. S., Fatayah, F., & Purwanto, K. K. (2023). The use of Android-based augmented reality media to improve student learning achievement in chemical bonding material. UNESA Journal of Chemical Education, 12(1), 17-22. https://doi.org/10.26740/ujced.v12n1.p17-22

Nurulhidayah, M. R., Lubis, P. H. M., & Ali, M. (2020). Pengaruh Model Pembelajaran Discovery Learning Menggunakan Media Simulasi PhET. Jurnal Pendidikan Fisika, 8(1), 95. https://doi.org/10.24127/jpf.v8i1.2461

Ocloo, F. E. (2023). Effect of Computer Simulation on Senior High School Students' Conceptual Understanding of Chemical Bonding. East African Journal of Education and Social Sciences, 4(5), 83-89. https://doi.org/10.46606/eajess2023v04i05.0322

Pangesti, W., & Radia, E. H. (2021). Meta Analisis Pengaruh Model Pembelajaran Discovery Learning Terhadap Hasil

Belajar IPA. Elementary School: Jurnal Pendidikan, 8(2), 281–286. https://doi.org/10.31316/esjurnal.v8i2.1313

Purba, J., & Fitri, R. A. (2024). Pengembangan e-Modul Berbasis Discovery Learning Dengan Bantuan Flip PDF pada Materi Ikatan Kimia. Jurnal Pendidikan Kimia FKIP Universitas Halu Oleo, 9(1), 26–39. https://doi.org/10.36709/jpkim.v9i1.79

Putra, I. N. T. A., & Kartini, K. S. (2020). Implementation of Mobile-Based Interactive Learning Media Case Study: Class XI Hydrocarbons Material. Jurnal Pendidikan Kimia Indonesia, 4(2), 43–52. https://doi.org/10.23887/jpk.v4i2.28536

Rahman, M., Latif, S., & Saban, M. M. (2022). Implementasi Model Discovery Learning Untuk Meningkatkan Kemampuan Literasi Sains. Jurnal Pendidikan Fisika, 10(2), 259. https://doi.org/10.24127/jpf.v10i2.5660

Rahmayani, A. L. (2019). Pengaruh Model Pembelajaran Discovery Learning dengan Menggunakan Media Video. Jurnal Pendidikan (Teori dan Praktik), 4(1), 59. https://doi.org/10.26740/jp.v4n1.p59-62

Rahmi, A., Fitriani, H., & Muna, N. (2021). Pengaruh Model Pembelajaran Cooperative Script dengan Media Kartu Gambar Terhadap Minat dan Hasil Belajar. Katalis, 4(1), 33–38. https://doi.org/10.33059/katalis.v4i1.3738

Ricardo, R., & Meilani, R. I. (2017). Impak Minat dan Motivasi Belajar terhadap Hasil Belajar Siswa. Jurnal Pendidikan Manajemen Perkantoran, 2(2), 188-201. https://doi.org/10.17509/jpm.v2i2.8108

Rizki, A., Khaldun, I., & Pada, A. U. T. (2021). Development of Discovery Learning Student Worksheets to Improve Students' Critical Thinking Skills. Jurnal Penelitian Pendidikan IPA, 7(4), 707–711. https://doi.org/10.29303/jppipa.v7i4.829

Saputri, A. C., & Wilujeng, I. (2023). The Effect of Discovery Learning Model Assisted by PhET Simulation on Students' Motivation and Critical Thinking Skills. Jurnal Penelitian Pendidikan IPA, 9(9), 7123-7130. https://doi.org/10.29303/jppipa.v9i9.4215

Sariati, K., Suardana, N. I., & Wiratini, N. M. (2020). Analisis Kesulitan Belajar Kimia Siswa Kelas Xi Pada Materi Larutan Penyangga. Jurnal Imiah Pendidikan dan Pembelajaran, 4(1), 86–97. https://doi.org/10.23887/jipp.v4i1.15469

Sariwati, L. N., Sunaryo, A., & Sukarmin, S. (2023). Meningkatkan Hasil Belajar Peserta Didik dengan Model Discovery Learning pada Materi Ikatan Kimia. Hydrogen: Jurnal Kependidikan Kimia, 11(3), 339. https://doi.org/10.33394/hjkk.v11i3.7914

Simbolon, R., & Koeswanti, H. D. (2021). Penerapan Model Pembelajaran Discovery Learning untuk Meningkatkan Minat Belajar Siswa pada Materi IPA. Jurnal Mimbar Ilmu, 26(1), 93-102. https://doi.org/10.23887/mi.v26i1.31934

Supratman, S., Zubaidah, S., et al. (2021). The Effect Size of Different Learning on Critical and Creative Thinking Skills of Biology Students. International Journal of Instruction, 14(3), 187–206. https://doi.org/10.29333/iji.2021.14311a

Tanjung, A. K. P., & Louise, I. S. Y. (2024). Development of Student Worksheets with Discovery Learning Models Based on Augmented Reality in Chemical Bonding Materials. Jurnal Penelitian Pendidikan IPA, 10(3), 1063–1074. https://doi.org/10.29303/jppipa.v10i3.6684

Wahyuni, S., Muyassaroh, A., et al. (2024). Pemahaman Konsep Peserta didik Menggunakan Pembelajaran Discovery Learning. Jurnal Riset Dan Praktik Pendidikan Kimia, 12(1), 34–41. https://doi.org/10.17509/jrppk.v12i1.69417

Winarni, S., & Ismono, I. (2021). Implementation of Discovery Learning Model to Improve Student's Conceptual Understanding on Reaction Rate Material. Indonesian Journal of Chemical Science and Technology (IJCST), 4(1), 26-34. https://doi.org/10.24114/ijcst.v4i1.26425