HYDROGEN
JURNAL KEPENDIDIKAN KIMIA
http://ojs.ikipmataram.ac.id/index.php/hydrogen/index

February 2023, 11(1)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 95-105

Analysis of Students' Predicting Skills in The Concept of Reaction Rate

Nurul Salima, Hairida, Ira Lestari*, Lukman Hadi, Masriani, Maria Ulfah
Study Program of Chemistry Education, FKIP, Tanjungpura University, Jl. Prof. Dr. H. Hadari Nawawi, Bansir Laut, Kota Pontianak, Kalimantan Barat, Indonesia
* Corresponding Author e-mail: ira.lestari@chem.edu.untan.ac.id

Article History
Received: 05-01-2023
Revised: dd-M-Year
Published: 15-02-2023

Keywords: collision theory; reaction rate factors; predicting skill

Abstract
The present research aimed to describe the skills of 11th grade students in predicting reaction rate material. The need for this study arose due to the inadequacy of the teacher's assessments to elaborate on the students' predictive skills, particularly in reaction rate material. The participants were 26 students from the 11th grade Science-2 class of State Senior High School (SMAN) 5 Pontianak. A quantitative description with a case study approach was used to gather data. The students were administered a questionnaire immediately after the reaction rate lesson, consisting of three questions. The mean scores of the students were analyzed to determine the results. The results showed that 50% of the students were categorized as having a very low level of skill in predicting reaction rate material, 27% as having a low level, 19% as having a medium level, 4% as having a high level, and 0% as having a very high level. It can be concluded that the majority of the students have a very low level of skill in predicting reaction rate material. The findings of this study have implications for teachers in creating more suitable lesson plans, syllabi, and media to align with the students' standard of competency outlined in the curriculum. This study may also serve as a foundation for future research on knowledge and education sustainability.

How to Cite: Salima, N., Hairida, H., Lestari, I., Hadi, L., Masriani, M., & Ulfah, M. (2023). Analysis of Students' Predicting Skills in The Concept of Reaction Rate. *Hydrogen: Jurnal Kependidikan Kimia*, *11*(1), 95-105. doi:https://doi.org/10.33394/hjkk.v11i1.6916

https://doi.org/10.33394/hjkk.v11i1.6916

INTRODUCTION

The rise of globalization in the educational sector in Indonesia has necessitated the adaptation of students' skills to meet the 21st century skill standards. The globalization in education system requires students, teachers, and other education stakeholders to develop 21st century skills, such as personality development, cooperation, communication, informal learning, productivity, and content creation. These skills are vital for the overall objective of 21st century learning, where individuals are evaluated based on their initiative, tenacity, responsibility, risk-taking, creativity, group work, socialization, comfort, managing, organizing, metacognitive skills, perseverance, and positive outlook towards failures (Zubaidah, 2017; Pramudita et al., 2021). The Competency Standards for Graduates of High School Level Education Units, as per Regulation No. 34 of 2018 by the Indonesian Minister of Education, highlights the importance of students being able to think and act creatively, productively, critically, independently, collaboratively, and communicate (Permendikbud No. 34/2018 tentang Standar Nasional Pendidikan SMK/MAK, 2018).

The development of science process skills (PPP) is crucial to enhance these skills. PPPs encompass the skills of observing, communicating, estimating, measuring, collecting data, classifying, inference, predicting, interpreting data, making hypotheses, controlling variables, defining variables, and drawing conclusions (Asy et al., 2017; Khery, 2013; Saputri &

Djumhana, 2020). These skills require students to be proficient in other aspects of PPPs, such as observation, classification, forecasting, communication, measurement, experimentation, and data interpretation.

PPPs play a crucial role in learning, as they help to improve thinking skills, facilitate student discoveries, build concepts, and support integrated learning for educators (Fajrina et al., 2021). PPPs are essential for maximizing learning in schools (Abdjul & Katili, 2021; Ango, 2002; Khery et al., 2013) and solving problems (Mu'minin et al., 2020). The indicators for PPPs include observing, forecasting, inference, categorizing, and communicating, where observing refers to making observations using the five senses, inference means describing observed objects, forecasting means predicting future events based on existing knowledge, facts, concepts, and principles, categorizing means grouping objects based on specific properties, and communicating means conveying the results (Widyaningrum & Agustini, 2021; Zeidan & Jayosi, 2014).

The development of predicting skills can support PPPs in students. Predicting skills refer to the ability to estimate future events based on existing patterns, such as concepts, principles, or theories (Zeidan & Jayosi, 2014). Predicting skills help students make informed decisions when solving problems (Fitri et al., 2020) and estimate the possibilities that may occur when a system is given treatment (Putri et al., 2022). According to Rahayu (2020), predicting involves imagining what might happen in an unobserved state. Lusidawaty et al. (2020) define predicting as estimating what will happen when a system is given treatment. In conclusion, predicting skills enable students to estimate or predict the possibilities that may occur when a system is given treatment based on existing patterns or concepts.

The ability to make predictions is heavily dependent on a student's prior knowledge. As such, students need to be guided to effectively utilize their prior knowledge as a foundation for making predictions, including in the study of chemical matter. Chemistry is a branch of science that examines the nature, structure, and changes of matter and energy, and encompasses not only knowledge, but also the process of knowledge discovery and development. The development of prediction skills can enhance science process skills, scientific attitudes, and cognitive abilities in chemistry (Gultom, 2018).

Interviews with chemistry teachers at State Senior High School 5 Pontianak revealed that the chemistry learning process, particularly in the area of reaction rate, has primarily focused on calculating the reaction order. As a result, other subtopics are not thoroughly explored. According to Pahriah and Hendrawani (2019), the reaction rate subtopic covers the concepts of reaction rate, factors affecting reaction rate, the reaction rate equation, reaction order, and collision theory. The assessment provided by teachers is generally in the form of presentation and discussion-based evaluations, lacking a systematic rubric to specifically assess students' prediction skills related to the factors that influence reaction rates. The reasons for this lack of comprehensive and curriculum-aligned assessment include a lack of understanding in designing non-test assessments, difficulty in creating a skills and attitudes assessment rubric, and difficulty in implementing process assessment in the learning process (Ulfah et al., 2021). Research conducted by Nisa et al. (2015) and Hairida (2018) also showed that teachers have not been able to fully develop the necessary learning tools for students.

Previous research has primarily focused on science process skills, such as the study entitled "Science Process Skills of Tadris Biology Students in the General Biology Course," which found that students' science process skills were classified as "fairly satisfactory," covering observing, classifying, interpreting data, predicting, hypothesizing, analyzing, planning experiments, using tools/materials, applying concepts, and communicating (Khairunnisa et al., 2020). Another study, "Analysis of Students' Science Process Skills on Reaction Rate Material Through the Bounded Inquiry Laboratory Learning Model," found that students' science

process skills were considered "sufficient" at a percentage of 57.94%, with the highest indicator being observing skills and the lowest being hypothetizing skills (Fitriana et al., 2019). This study, however, focuses specifically on predicting skills as the main variable measured to provide a more detailed picture of students' abilities. A different study, "Analysis of Predicting Ability in Physics Learning for 12th-grade science students of SMA Negeri 9 Makassar," found that students' predictive ability was categorized as "moderate." Students were unable to effectively apply concepts they had learned, resulting in difficulties and prolonged problem-solving times (Fitri et al., 2020). This study, however, focuses on students' predicting skills in chemistry, specifically the reaction rate material. The differences in the fields of science studied make this research novel and serve as a foundation for further research.

Table 1. Matrix of Previous Research based on Publications in Indonesia

No	Tittle and Authors	Finding	Relevance	Research Focus
1.	Analisis Keterampilan Proses Sains Siswa dalam Pembelajaran Rangkaian Seri Paralel Menggunakan Metode Praktikum : Restu Yusdistira Putri, Sudarti, Trapsilo Prihandono (2022)	The practicum method is able to improve student learning outcomes with an N-gain of 0.31.	This research has relevance based on the skills studied, namely science process skills	Predicting skills
2.	Profil Keterampilan Proses Sains Siswa dalam Praktikum Titrasi Asam Basa : Made Darmaprathiwi Adiningsih, I Wayan Karyasa, I Wayan Muderawan (2019)	Indikaator science process skills mastered by students are the skills of measuring, conducting experiments, observing, predicting, interpreting, applying concepts, and communicating. Less mastered skills are inference skills, untrained skills i.e. the skills of formulating hypotheses, controlling variables, designing investigations, and classifying	The similarity of skills studied is the science process skills	Predicting skills and reaction rate material
3.	Analisis Keterampilan Proses Sains Peserta Didik pada Materi Laju Reaksi Melalui Model Pembelajaran Bounded Inquiry Laboratory : Fitrina, Yenni Kurniawati, Lisa Utami (2019)	Science process skills as a whole are categorized simply by percentage 57.94%.	Relevance lies in the meticulous material	Predicting skills

The purpose of this study is to examine the predicting skills of high school students in the subject of chemistry, specifically in the reaction rate material. This research aims to provide an overview of students' predicting abilities, thereby enabling educators to identify areas for improvement in chemistry learning. The study is motivated by the need for more comprehensive and curriculum-aligned assessments in high school chemistry, as well as a lack of research specifically examining predicting skills in this context.

The study will be conducted by interviewing chemistry teachers at State Senior High School 5 Pontianak, as well as assessing students' predicting skills through a systematic rubric. The results of this study will be compared to past research, including studies on science process skills, to determine the specific areas in which students possess strong predicting skills and areas in which they may require additional support. The findings are expected to offer important implications for the design of the chemistry learning process, including the development of appropriate models, media, and assessment instruments. Furthermore, the findings of this research can serve as a reference for future studies, providing a foundation for further exploration and discovery in this field.

This research is significant because the results can be used as a reference in the design of the learning process, such as the creation of appropriate models, media, and assessment instruments, to enhance the complexity and alignment of chemistry assessments in high school with the curriculum's development and needs. Additionally, this research can serve as a basis for other researchers to develop new models, media, and assessment instruments and lead to further discoveries.

METHOD

This study is a quantitative, descriptive case study aimed at exploring the predicting skills of 11th grade science students of State Senior High School (SMAN) 5 Pontianak. The study was conducted using the following steps (Figure 1):

- Observing problems through interviews with teachers in the field of study.
- Compiling research instruments.
- Validating the instruments with the help of 2 expert lecturers, resulting in a validity score of 4.00.
- Conducting the research implementation through a questionnaire-based post-test with 26 11th grade science-2 students.
- Processing the data collected from the questionnaire.
- Compiling and presenting the research results.

The study used a sample of 26 11^{th}-grade science-2 students and employed a questionnaire-based post-test to gather data. The questionnaire consisted of 3 questions that were designed to measure the students' predicting skills, specifically their ability to predict the reaction rate, explain their predictions, and link their reasoning to the collision theory. The data collected was analyzed by calculating the average of the students' scores, according the following formula:

$$\bar{X} = \frac{\Sigma X}{n}$$

where $\bar{X}$ is average, ΣX is score and n in the number of data.

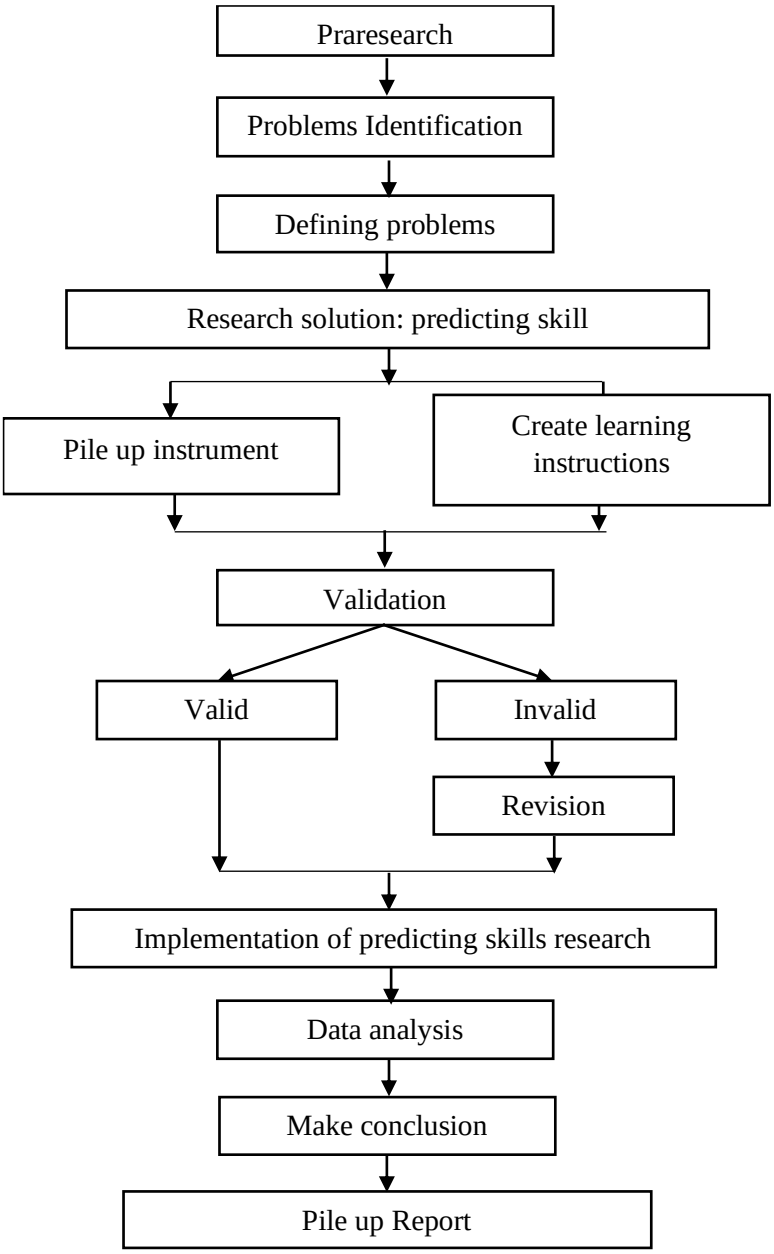

Figure 1. Research flowchart

RESULT AND DISCUSSION

Result

The results of the predictive skills assessment of the 11th-grade science-2 students of SMAN 5 Pontianak are presented in Table 2. The average score of the predictive skills of the 26 students from the 11th-grade science-2 class of SMAN 5 Pontianak was 2.96 out of a maximum score of 9. The average score indicates that most students scored lower than half the total score. The students were only able to make predictions without being able to explain the number of particles involved and the collision theory taking place during the reaction, as described in the post-test problem on ginger extraction.

The scores were categorized into five levels: very high, high, medium, low, and very low (Fitri et al., 2020). The distribution of scores and categories is presented in Table 3. Based on the

score categorization table, it was observed that the majority of the students scored 0-2 points, which indicates a very low level of predictive skills.

Table 2. The student's skill score predicts on the material the reaction rate from 26 samples

Statistics (score)	Score Statistics
Maximum	9
Minimum	0
Highest	8
Lowest	0
Average	2.96

Tabel 3. Categorization of predicting skill of 11th grade science-2 students SMAN 5 Pontianak

INTERVAL	CATEGORY	FREQUENCY	PERCENTAGE
8,1 - 10	Very high	0	0%
6,1 - 8	High	1	4%
4,1 - 6	Medium	5	19%
2,1 - 4	Low	7	27%
0 - 2	Very low	13	50%

Discussion

The aim of this study was to assess the predictive skills of 11th grade science-2 students of SMAN 5 Pontianak in relation to the ginger extraction discourse. The results, as shown in Table 3, indicate that 50% of the students scored in the range of 0-2, which is categorized as very low. This suggests that the majority of students were unable to predict the reaction rate. A further 27% of students scored 2.1-4 and were categorized as low, indicating that they were able to make predictions based on one factor but not able to explain the reasons and link them to the collision theory. 19% of students scored 4.1-6 and were categorized as moderate, indicating that they were able to give predictions but not able to provide explanations or connect them to the collision theory. Only 4% of students scored 6.1-8, which is considered high, meaning they were able to make predictions, provide explanations, but not link them to the collision theory. None of the students scored 8.1-10, which would be considered very high, indicating mastery in predicting, explaining, and linking the given information to the collision theory.

Based on post-test questions and answers, the students expressed several difficulties in completing the task. These difficulties included not understanding the meaning of the questions, a lack of familiarity with the material, not understanding the terms used in the ginger extraction discourse, and feeling tired after conducting the practical. These difficulties resulted in students being unable to predict the reaction rate, explain the relationship between the reaction rate and the number of particles, and collision theory. These results are consistent with previous research (Manurung, 2020; A. N. Putri & Muhartati, 2019) which found that students' predicting skills are low due to a lack of familiarity with the assessments and a lack of understanding of the concepts. Improving students' understanding and skills is crucial for achieving more effective and efficient learning outcomes (Suryawati, 2022).

The predictive skills tested in this study consisted of three indicators: predicting the reaction time based on changes in touch plane surface area, concentration, and temperature; explaining the effect of these changes on the number of particles involved in the reaction; and connecting the explanations given to the collision theory. The questions were in the form of fill-in-the-

blank and each question was worth three points based on the previously described indicators. The scores per indicator and sub-material are presented in Table 4.

The first indicator in the first sub-material assessed students' ability to predict the effect of changes in the surface area of the touch plane on the reaction rate. The expected answer was that a smaller surface area would result in a slower reaction due to a smaller number of particles involved and less effective collisions. 92% of the students provided the correct answer, while 8% did not respond. This high rate of correct answers can be attributed to the teacher's use of an easily relatable example of the influence of surface area on reaction rate in the form of dissolving sugar cubes and granulated sugar during the learning process (Kinasih & Sinaga, 2020). Research by Manu & Nomleni (2018) and Alvionita et al. (2021) also supports the importance of meaningful learning in facilitating understanding and internalization.

Table 4. Predicting skill of 11th grade science-2 students per indicator

Indicator	Sub chapter	Frequency	Percentage
Predicting reaction rate	Interface	24	92
	Temprature	18	69
	Concentration	13	50
Describing relationship between prediction and amount of particle	Interface	10	38
	Temprature	6	23
	Concentration	4	15
Associating reason with collision theory	Interface	1	4
	Temprature	0	0
	Concentration	0	0

The second sub-topic, which concerns the influence of temperature and concentration on the reaction rate, was answered correctly by 69% and 50% of students, respectively. Although the expected answer was that the reaction rate would be slower, a large percentage of students answered incorrectly. This was due to the students' unfamiliarity with laboratory terms such as ethanol solvents, extractions, and isolated compounds. As a result, they had a limited understanding of the relationship between the reaction rate factor and the reaction rate, as they rarely interact with the materials used during the experiment. This lack of knowledge affects their predicting skills and concept comprehension (Zuhaida, 2019; Zuhra et al., 2021).

The third indicator evaluated the students' ability to provide reasons for their predictions. The expected answer was that a change in the surface area of the reacting particles would result in fewer particles coming into contact with the solvent because the surface area is smaller. Only 38% of students gave the correct reason, while the rest answered incorrectly or did not give a reason.

In the sub-topic on the influence of temperature, only 15% of students were able to answer that a decrease in temperature would reduce the kinetic energy of the reaction. Similarly, in the sub-topic on the influence of concentration, only 10% of students were able to explain that a decrease in concentration would result in fewer particles involved in the reaction. This was because the students were not familiar with questions requiring them to explain their answers (Munawwarah et al., 2020).

The fourth indicator tested students' ability to link their reasons to the collision theory. Unfortunately, only one student was able to answer correctly, while the remaining 25 students did not answer. The expected answer was that the number of effective collisions would decrease as the number of particles and their kinetic energy decreased. To answer correctly, students need to have an understanding of the relationship between the reaction rate and the number of effective collisions. This requires building a new understanding by connecting prior knowledge with new information (Siregar & Nensi, 2020).

The results of the student predicting skills test showed that 50% of students had predicting skills in the range of 0-2, meaning their abilities were very low. This is likely because students are not familiar with questions requiring them to make predictions. With more frequent exposure to prediction-related questions, students can become more familiar with complex grading systems and improve their ability to predict in problem-solving (Murlia & Rudi, 2020).

Predicting skills are crucial for students, as they make it difficult for them to predict the outcomes of a reaction if they are unable to make predictions. This, in turn, affects their overall learning outcomes. Therefore, a learning model accompanied by appropriate assessment tools is needed to train students in making predictions, especially in reaction rate materials. This will help students become more familiar and skilled in predicting the outcomes of a reaction with different treatments.

The implications of this study, which provide insight into students' skills in predicting reaction rate materials, can help educators design more effective learning models and media that align with the expected competency standards of the curriculum. This can, in turn, improve the quality of chemistry education in schools. This study can also serve as a foundation for future research to continue to advance the field of science.

One of the limitations of this study was improper timing, leading to less-than-optimal learning outcomes. The focus on the reaction rate factor during the experiment left limited time for delivering the material, resulting in students having a shallow understanding of the topic. Subsequent researchers are recommended to manage their time more effectively to ensure their research is implemented as designed.

CONCLUSION

In conclusion, this research paper aimed to assess the predicting skills of students on reaction rate material in chemistry. The results showed that the majority of students had low predicting skills, with only a small percentage able to answer correctly. This indicates that students are not familiar with the questions that require predictions and highlights the need for a more effective learning model accompanied by appropriate assessment instruments. This study provides important information for educators to formulate better learning designs, models, and media that align with the competency standards expected by the curriculum, leading to an increase in the quality of chemistry learning in schools. The results of this research can also serve as a basis for further studies to develop and advance science education. However, the study's limitations, such as improper timing, suggest the need for future research to manage the implementation time more effectively.

RECOMENDATION

Predicting skills in students should be described in detail through the use of valid and reliable instruments so that educators can provide the right model or method. Instrument making and the use of models require quite a lot of preparation so educators must be creative and innovative in compiling learning tools in the classroom. Although sometimes educators are faced with problems with facilities and the interests and abilities of students who have not been able to keep up with the expected educational standards.

ACKNOWLEDGEMENTS

Thank you to COMDEV BIDIKMISI the party who financed the lectures and research. Thank you to the supervisors and examiners who are willing to accompany and help complete this paper.

BIBLIOGRAPHY

Abdjul, T., & Katili, N. (2021). Penerapan Pembelajaran Berbasis Kearifan Lokal Terhadap Keterampilan Proses Sains Siswa. *Jambura Physics Journal*, *3*(2), 112–119. https://doi.org/10.34312/jpj.v3i2.11166

Alvionita, D., Murti, A. B., Rasyid, A., Gani, F., & Info, A. (2021). Studi Literasi : Pelopor Pembelajaran Bermakna Menggunakan Teknologi Augmented Reality pada Topik Lingkungan di Era Merdeka Belajar. *Bioilmi, Jurnal Pendidikan*, *VII*(II), 73–82. https://doi.org/https://doi.org/10.19109/bioilmi.v7i2.11510

Ango, M. L. (2002). Mastery of Science Process Skills and Their Effective Use in the Teaching of Science: An Educology of Science Education in the Nigerian Context. *International Journal of Educology*, *16*(1), 11–30. https://files.eric.ed.gov/fulltext/ED494901.pdf

Asy, M., Fitriani, H., Pendidikan, P., & Mataram, F. I. (2017). *Literatur Reviu Keterampilan Proses Sains sebagai Dasar Pengembangan Keterampilan Berpikir Tingkat Tinggi Keterampilan Proses Sains sebagai Dasar Pengembangan Keterampilan Berpikir Tingkat*. *5*(1), 1–7.

Fajrina, S., Nulhakim, L., & Taufik, A. N. (2021). Pengembangan Instrumen Performance Assessment Praktikum untuk Mengukur Keterampilan Proses Sains (KPS) Siswa SMP Kelas VIII pada Tema Makananku Kesehatanku. *PENDIPA Journal of Science Education*, *6*(1), 105–112. https://doi.org/10.33369/pendipa.6.1.105-112

Fitri, Herman, & Haris, A. (2020). *Analisis Kemampuan Memprediksi dalam Pembelajaran Fisika Peserta Didik Kelas XII MIA SMA Negeri 9 Makassar. perkembangan teknologi , yang menuntut suatu masyarakat untuk menjadi sumber daya manusia yang perubahan , yaitu diantaranya pengetahuan dan ketera*. *02*, 100–107.

Fitriana, F., Kurniawati, Y., & Utami, L. (2019). Analisis Keterampilan Proses Sains Peserta Didik Pada Materi Laju Reaksi Melalui Model Pembelajaran Bounded Inquiry Laboratory. *JTK (Jurnal Tadris Kimiya)*, *4*(2), 226–236. https://doi.org/10.15575/jtk.v4i2.5669

Gultom, E. C. (2018). *Penerapan Model Pembelajaran Predict, Observe, Explain (POE) pada Materi Larutan Elektrolit dan Non Elektrolit untuk Meningkatkan Keterampilan Proses Sains, Sikap Ilmiah, dan Kemampuan Kognitif Siswa*. *9*(1), 76–83.

Hairida, H. (2018). Penilaian Sikap Siswa Dalam Pembelajaran Kimia Melalui Teknik Self Assessment Dan Peer Assessment. *Jurnal Pendidikan Matematika Dan IPA*, *9*(2), 37. https://doi.org/10.26418/jpmipa.v9i2.25832

Ilmi, N., Desnita, D., Handoko, E., & Zelda, B. (2016). *Pengembangan Instrumen Penilaian Keterampilan Proses Sains pada Pembelajaran Fisika SMA*. *V*, SNF2016-RND-57-SNF2016-RND-62. https://doi.org/10.21009/0305010213

Khairunnisa, K., Ita, I., & Istiqamah, I. (2020). Keterampilan Proses Sains (KPS) Mahasiswa Tadris Biologi pada Mata Kuliah Biologi Umum. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *1*(2), 58. https://doi.org/10.20527/binov.v1i2.7858

Khery, Y. (2013). Kesadaran Metakognitif, Proses Sains, dan Hasil Belajar Kimia Mahasiswa Divergen dan Konvergen dalam PBL. *Jurnal Pendidikan Sains*, *1*(4), 343–351.

Khery, Y., Subandi, S., & Ibnu, S. (2013). Metakognitif, Proses Sains, dan Kemampuan Kognitif Mahasiswa Divergen dan Konvergen dalam PBL. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *1*(1), 37. https://doi.org/10.33394/j-ps.v1i1.517

Kinasih, S., & Sinaga, K. (2020). Kajian Penerapan Teori Pembelajaran Bermakna Ausubel Berdasarkan Perspektif Alkitabiah Pada Materi Hidrokarbon [a Study on the Application of Ausubel'S Meaningful Learning Theory on Hydrocarbon Chemical Learning Based on a Biblical Perspective]. *Polyglot: Jurnal Ilmiah*, *16*(2), 141. https://doi.org/10.19166/pji.v16i2.2128

Lusidawaty, V., Fitria, Y., Miaz, Y., & Zikri, A. (2020). Pembelajaran Ipa Dengan Strategi Pembelajaran Inkuiri Untuk Meningkatkan Keterampilan Proses Sains Dan Motivasi Belajar Siswa Di Sekolah Dasar. *Jurnal Basicedu*, *4*(1), 168–174. https://doi.org/10.31004/basicedu.v4i1.333

Manu, T. S. N., & Nomleni, F. T. (2018). Pengaruh Metode Pembelajaran Karya Kelompok Terhadap Keterampilan Proses Sains Dengan Kovariabel Kemampuan Berpikir Kreatif Siswa Pada Mata Pelajaran Biologi. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *8*(2), 167–179. https://doi.org/10.24246/j.js.2018.v8.i2.p167-179

Manurung, I. F. U. (2020). Identifikasi Keterampilan Proses Sains Mahasiswa Melalui Penggunaan Lembar Kerja Berbasis Inquiry Pada Mata Kuliah Konsep Dasar IPA. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699.

Mu'minin, A. A., Dasna, I. W., & Suharti, S. (2020). Efektivitas POGIL pada Pembelajaran Kesetimbangan Kimia terhadap Keterampilan Proses Sains dan Hasil Belajar Siswa dengan Kemampuan Awal Berbeda. *Hydrogen: Jurnal Kependidikan Kimia*, *8*(1), 29. https://doi.org/10.33394/hjkk.v8i1.2659

Munawwarah, M., Laili, N., & Tohir, M. (2020). Keterampilan Berpikir Kritis Mahasiswa Dalam Memecahkan Masalah Matematika Berdasarkan Keterampilan Abad 21. *Alifmatika: Jurnal Pendidikan Dan Pembelajaran Matematika*, *2*(1), 37–58. https://doi.org/10.35316/alifmatika.2020.v2i1.37-58

Murlia, S., & Rudi, L. (2020). *Analisis Keterampilan Proses Sains (KPS) Mahasiswa Pendidikan Kimia pada Mata Kuliah Praktikum Dasa-dasar Kimia Analitik Materi Titrasi*. *5*(1), 1–9.

Nisa, B. C., Suryati, S., & Dewi, C. A. (2015). Pengembangan Bahan Ajar KAPRA Berbasis Literasi Sains Pada Materi Laju Reaksi Untuk Kelas XI SMA / MA. *Hydrogen: Jurnal Kependidikan Kimia*, *3*(1), 228. https://doi.org/10.33394/hjkk.v3i1.663

Pahriah, P., & Hendrawani, H. (2019). Pengembangan Bahan Ajar Laju Reaksi Dengan Multipel Representasi Berbasis Inkuiri. *Hydrogen: Jurnal Kependidikan Kimia*, *6*(1), 32. https://doi.org/10.33394/hjkk.v6i1.1598

Pramudita, I. F. E., Praherdhiono, H., & Adi, E. P. (2021). Studi Keterampilan Abad 21 Mahasiswa Dalam Memilih Peminatan. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *4*(3), 251–259. https://doi.org/10.17977/um038v4i32021p251

Putri, A. N., & Muhartati, E. (2019). Keterampilan Proses Sains Awal Mahasiswa Pendidikan Biologi Pada Matakuliah Biologi Umum. *Pedagogi Hayati*, *2*(2), 1–5. https://doi.org/10.31629/ph.v2i2.844

Putri, R. Y., Sudarti, & Prihandono, T. (2022). Analisis Keterampilan Proses Sains Siswa dalam Pembelajaran Rangkaian Seri Paralel melalui Metode Praktikum. *EDUMASPUL JURNAL PENDIDIKAN*, *6*(1), 497–502. https://doi.org/10.36088/fondatia.v6i1.1689

Rahayu, A. (2020). Analisis Keterampilan Proses Sains Mahasiswa Pada Praktikum Dasar-Dasar Kimia Analitik. *Dalton : Jurnal Pendidikan Kimia Dan Ilmu Kimia*, *3*(1), 1–10. https://doi.org/10.31602/dl.v3i1.3102

Rahma, T. Y., & Kusdiwelirawan, A. (2020). *Analisis Keterampilan Proses Sains Siswa Pada Pembelajaran Fisika Topik Usaha Dan Energi*. *2*(1), 124–127.

Permendikbud No. 34/2018 tentang Standar Nasional Pendidikan SMK/MAK, (2018).

Saputri, A. E., & Djumhana, N. (2020). Keterampilan Proses Sains dan Sikap Ilmiah Mahasiswa PGSD dalam Belajar Ilmu Pengetahuan Alam (IPA). *DWIJA CENDEKIA: Jurnal Riset Pedagogik*, *4*(1), 35. https://doi.org/10.20961/jdc.v4i1.36019

Siregar, T., & Nensi, M. (2020). *Model Pembelajaran Generatif terhadap Hasil Belajar Kimia pada Materi Ikatan Kimia*. *2*(2), 35–43.

Suryawati, E. (2022). *Penerapan Metode Inquiri Dalam Meningkatkan Keterampilan Memprediksi Dan Pemahaman Konsep Belajar Siswa Pada Pokok Bahasan Perubahan Wujud Benda Kelas V SD Islam NW Ceking Tahun Pelajaran 2021-2022*. *8*(1), 1131–1139.

Ulfah, M., Hairida, H., Arfiyanti, F., Permasari, N., & Sabila, J. A. (2021). Analisis Permasalahan Pendidik IPA Dalam Proses Penilaian Pembelajaran. *Jurnal IPA & Pembelajaran IPA*, *5*(2), 186–196. https://doi.org/10.24815/jipi.v5i2.21163

Widyaningrum, A., & Agustini, R. (2021). Analisis Keterampilan Proses Sains Peserta Didik Pada Materi Ikatan Kimia Kelas X SMA Negeri 6 Madiun. *Jurnal Inovasi Pembelajaran Kimia*, *3*(1), 1. https://doi.org/10.24114/jipk.v3i1.23032

Zeidan, A. H., & Jayosi, M. R. (2014). Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students. *World Journal of Education*, *5*(1), 13–24. https://doi.org/10.5430/wje.v5n1p13

Zubaidah, S. (2017). *Keterampilan abad ke-21: keterampilan yang diajarkan melalui pembelajaran*. *December 2016*.

Zuhaida, A. (2019). Analisis Level Literasi Laboratorium Kimia Dari Calon Guru. *Jurnal Inovas Pendidikan Kimia*, *13*(2), 2349–2359.

Zuhra, F., Nurhayati, & Septian. (2021). Pengenalan Alat-Alat Laboratorium Ipa Untuk Meningkatkan Keterampilan Proses Sains Di Era New Normal. *JMM (Jurnal Masyarakat Mandiri)*, *5*(2), 396–404.