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Portrait of Observing, Inferring, and Predicting Skills of Junior High School Students

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Abstract: The goal of science learning is achieved when students master key skills: observing, inferring, and predicting. Field studies indicate that teachers face challenges in comprehensively assessing these skills. This study aims to portray the observing, inferring, and predicting skills of junior high school students in Tanjungpinang. A quantitative descriptive method was employed, with a target population of eighth-grade students from state junior high schools in Tanjungpinang. Stratified random sampling based on school accreditation levels resulted in a sample of 208 students. Data collection involved a test on work and simple machines material, which was analyzed using descriptive statistics. The findings reveal that the average interval scores for observing, inferring, and predicting skills were 13.52, 5.49, and 1.93, respectively, placing them in the medium category, indicating potential for further development. These results highlight the need for targeted quality improvement programs and increased resource support to enhance science learning. Implementing diverse strategies and innovations in science teaching materials is essential to improve these skills.

Keywords: Inferring; Junior high school; Observing; Predicting

Introduction

The essence of science is an interpretation of nature and various phenomena that are arranged into a set of theories and concepts in an organized manner to be used for human life (Addis & Powell-Coffman, 2018). Science learning is intended so students have scientific knowledge and expertise in solving problems (Fatonah & Prasetyo, 2014; Rusni et al., 2020; Setiawaty et al., 2018). In its implementation, science learning emphasizes students' science process skills. The results of the PISA (Programme for International Student Assessment) research in 2022 showed that the science ability of Indonesian students is relatively low compared to other ASEAN countries (OECD, 2023). The results of the PISA study are often used as a basis for studies in development programs and improving the quality of education (Santoso & Prodjosantoso, 2020). Indonesia's low PISA score in the field of science indicates a gap in students' mastery of basic science competencies. The PISA results show that Indonesian students still have difficulty applying scientific knowledge to analyze phenomena, interpret data and provide scientific explanations. Without mastery of basic skills, students will have difficulty developing the high-level science skills tested in PISA. Therefore, to increase the scientific literacy of Indonesian students as a whole, it is necessary to carry out an in-depth analysis of the mastery of basic science process skills as the foundation of science learning.

In the context of science learning, science process skills play a central role (Idul & Caro, 2022; Prasojo, 2016). These skills help students not only understand scientific facts, but also enable them to develop critical thinking, logical thinking, and exploring concepts with scientific methods (Purwanti, 2017). Science process skills involve various stages that include observation, formulating scientific questions, planning experiments

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or research, collecting data, analyzing results, and concluding findings (Maizaliani et al., 2024). These skills also include the ability to communicate effectively, both verbally and in writing, as well as the ability to work together in a group to achieve a common goal.

The importance of science process skills in science learning can enable students to approach science concepts in a more in-depth way, help them develop problem-solving skills that are invaluable in daily life (Jusuf et al., 2021), stimulate students' curiosity, help students relate theoretical concepts to their practical applications (Rosanti et al., 2023), provide a better understanding of how scientists work and how scientific discoveries are made (Ozdeniz et al., 2023; Yulihapsari et al., 2023). Science process skills refer to the abilities that students must develop and apply through both physical and mental activities to enhance their science learning (Akbar et al., 2019; Basuki et al., 2019). These skills are essential for conducting scientific investigations and gaining deeper, more meaningful learning experiences (Yuliskurniawati et al., 2019). Thus, science process skills are not just an additional component in science learning but are the essence of effective science education (Akbariah et al., 2023; Haerani et al., 2023; Yuberti et al., 2020) that crucial for developing a scientifically literate citizenry (Deehan et al., 2024).

Equipping students with these skills not only helps them become better learners, but it also helps them understand the world around them better and provides a solid foundation for participating in an increasingly science and technology-oriented society (Hunegnaw et al., 2024). Therefore, the goal of learning science will be achieved if students have the main skill components in science learning. The skills in question are observing, inferring, and predicting (Lukman et al., 2023; Rezba et al., 2021). Observing, inferring, and predicting skills are basic skills that are expected to be a provision for students to be implemented in daily life. Observing skills are a complex activity, involving all aspects of the skills possessed (Saleh et al., 2024). This skill is a basic skill that must be possessed by students when carrying out the science process. In science learning, observation is defined as the activity of recording a phenomenon with scientific objectives (Hasanah, 2016). Therefore, observation is also often referred to as a foundation or foothold when carrying out scientific methods. Observing skills use the five senses that humans have, and the results are referred to as facts (Maranan, 2017; Sheeba, 2013). Through observing skills, the thinking competencies needed in the 21st century can be realized. This is by research conducted by Setyawarno & Kurniawati (2022) that science learning that includes observing skills will result in the development of higher-level thinking skills.

The next basic skill is inferring. Inferring skills are making provisional conclusions based on observation facts (Darmaji et al., 2018). Activities in inferring skills require students to build a concept based on the results of observation and relate it to the theory that has been learned (Oktafiani et al., 2017). Then, the process that must be carried out after observing, and inferring is predicting. Predicting skills are basic skills in science learning. These skills function for students to make estimates about events that may occur based on the formed data patterns (Maranan, 2017; Safaah et al., 2017).

The results of interviews with junior high school teachers in Tanjungpinang obtained information that teachers have never conducted further analysis related to the skills of the science process during learning activities. The assessment of the ability to observe, inferring, and predicting in detail has never been done by teachers. As a result, the assessment of individual abilities cannot be carried out by teachers. Based on the description of observing, inferring, and predicting skills, it can be concluded that these abilities are interrelated, so students need to have them in science learning. However, research conducted by Ongowo & Indoshi (2013) shows that these basic skills have not been demonstrated by students. The study results showed that the percentage of observing skills was 32.24%; inferring by 13.13% and predicting by 0.89%. This research has special urgency because it will provide comprehensive baseline data about the basic science processing skills of students in Tanjungpinang, which has never been analyzed in depth. It is hoped that the results of this research can contribute to the development of more effective science learning programs, increasing teacher competence in assessing science process abilities, as well as improving science education policies at school and regional levels. Therefore, the researcher is interested in researching the portrait of the ability to observe, inferring, and predicting junior high school students in Tanjungpinang.

Method

The method used in this study is a quantitative descriptive method. The population in this study is grade VIII students of State Junior High School in Tanjungpinang. Sampling was carried out by stratified random sampling technique. The determination of strata is seen based on school accreditation in the 2023/2024 school year. Each school used as a research sample met the representativeness of the accreditation level, namely A, B and C. The researcher selects schools representing each accreditation level. Subsequently, one class group from grade VIII is selected from each school to serve as

the research sample. The sample in this study is presented in Table 1.

Table 1. Research sample

School name	Accreditation	Lots of samples
SMP N 1 Tanjungpinang	A	34
SMP N 4 Tanjungpinang	A	37
SMP N 5 Tanjungpinang	A	36
SMP N 10 Tanjungpinang	B	21
SMP N 12 Tanjungpinang	B	33
SMP N 13 Tanjungpinang	C	29
SMP N 14 Tanjungpinang	C	18
Amount		208

The research flow used can be seen as shown in Figure 1.

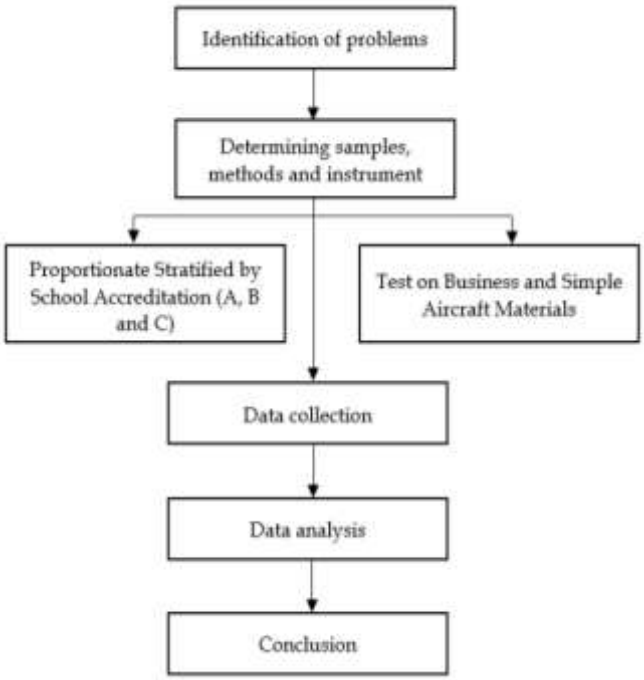

Figure 1. Research flow

A test was employed as the data collection technique in this research. The data collection technique used in this research is a test and the test instrument consists of essay covering the subject matter of work and simple machines. The test given to students was carried out for 80 minutes and then analyzed using an assessment rubric of 0-4. Furthermore, the scores obtained are interpreted into several criteria to determine the level of ability of each indicator and each school. In addition, the test has been validated by four experts in science education. The test results were analyzed using descriptive statistics to determine the distribution of students' ability levels. The interpretation of the values refers to the interval criteria presented in Table 2 below (Istiyono, 2020).

Table 2. Student ability criteria

Category	Intervals
Very high	$\theta > Mi + 1.5\ SBi$
High	$Mi + 0.5\ SBi < \theta \leq Mi + 1.5\ SBi$
Currently	$Mi - 0.5\ SBi < \theta \leq Mi + 0.5\ SBi$
Low	$Mi - 1.5\ SBi < \theta \leq Mi - 0.5\ SBi$
Very low	$\theta \leq Mi - 1.5\ SBi$

Result and Discussion

The results of the analysis conducted using a short-fill test showed that the skills of observing, inferring, and predicting students in Tanjungpinang were classified as moderate. The results of the analysis are presented in Table 3.

Table 3. Categories of student ability scores

Category	Intervals	The number of students	(%)
Very high	$\theta > 33$	8	3.85
High	$25.67 < \theta \leq 33$	53	25.48
Currently	$18.33 < \theta \leq 25.67$	68	32.69
Low	$11 < \theta \leq 18.33$	51	24.52
Very low	$\theta \leq 11$	28	13.46
Average		20.938 (Currently)	

Based on Table 3, information was obtained that as many as 32.69% with a total of 68 students had observing, inferring, and predicting skills in the medium category. Meanwhile, the lowest percentage of 3.85% with several 8 students shows that only a few students have very high skills. The high category of student skills is at 25.48% with a total of 53 students. Then, 24.52% of students, or 51 people have skills with a low category. The category of very low student abilities was owned by 28 students with a percentage of 13.46%. The average skills of students in each school are presented in Table 4.

Table 4. Average student grades by school

School name	Average	Category
SMP N 1 Tanjungpinang	27.85	High
SMP N 4 Tanjungpinang	24.73	Currently
SMP N 5 Tanjungpinang	20.81	Currently
SMP N 10 Tanjungpinang	18.44	Currently
SMP N 12 Tanjungpinang	15.66	Low
SMP N 13 Tanjungpinang	13	Low
SMP N 14 Tanjungpinang	12.76	Low

In general, the observing, inferring, and predicting skills of junior high school students in Tanjungpinang are in three different categories, namely high, medium and low. The high category is owned by students of SMP N 1 Tanjungpinang with an average interval score of 27.85. Meanwhile, the medium category was by students of SMP N 4, 5 and 10 Tanjungpinang with an average score of 24.73, 20.81 and 18.44 respectively. Then, the low category was by students of SMP N 12, 13, and 14 Tanjungpinang with an average score of 15.66, 13, and 12.76 respectively.

Based on the results of the data analysis, it can be concluded that school students with higher accreditation have better abilities (Aswar et al., 2019; Safahi et al., 2019). School accreditation appears to be a reliable indicator of science learning quality, particularly in developing observation, inference and prediction skills. Therefore, targeted quality improvement programs and greater resource support are needed for schools with B and C accreditation to enhance their learning quality, especially in aspects of science learning. Furthermore, experiences and best practices from A-accredited schools need to be documented and shared as development models for other schools.

The results of the study show that the observing skills possessed by students are on average in the medium category, by research conducted by Mariana & Kinasih (2021). This means that learning at school has been able to facilitate students to use all senses appropriately, determine the results of observations quantitatively and describe the objects observed (Martin, 2016). The categories of students' observing abilities are presented in detail in Table 5.

Table 5. Categories of students' observing ability scores

Category	Intervals	The number of students	(%)
Very high	$\theta > 18$	27	12.98
High	$14 < \theta \leq 18$	66	31.73
Currently	$10 < \theta \leq 14$	61	29.33
Low	$6 < \theta \leq 10$	43	20.67
Very low	$\theta \leq 6$	11	5.29
Average		13.52 (Currently)	

In line with observation skills, the average interval of inferring skills also falls into the medium category. This is consistent with Chen et al. (2021) findings, which showed that inferring skills are in the moderate category. Science learning in schools has been able to compile inferences according to data, compile inferences according to objectives, connect objects and observed events, explain observations to show the causes and interpret graphs, tables and other experimental data (Martin, 2016). The categories of students' inferring abilities are presented in detail in Table 6.

Furthermore, the results of the study show that the average student's predicting skills are in the low category according to the research conducted by Darmaji et al. (2018) and Ong et al. (2015). Thus, students have not been able to make simple predictions or test a prediction (Martin, 2016). The category of students' predicting ability is presented in detail in Table 7.

Table 6. Categories of students' inferring ability scores

Category	Intervals	The number of students	(%)
Very high	$\theta > 9$	28	13.46
High	$7 < \theta \leq 9$	29	13.94
Currently	$5 < \theta \leq 7$	36	17.31
Low	$3 < \theta \leq 5$	51	24.52
Very low	$\theta \leq 3$	64	30.77
Average		5.49 (Currently)	

Table 7. Categories of students' predicting ability scores

Category	Intervals	The number of students	(%)
Very high	$\theta > 6$	9	4.33
High	$4.67 < \theta \leq 6$	13	6.25
Currently	$3.33 < \theta \leq 4.67$	21	10.10
Low	$2 < \theta \leq 3.33$	20	9.62
Very low	$\theta \leq 2$	145	69.71
Average		1.93 (Very low)	

Based on the results of the research, information was obtained that the skills of observing, inferring, and predicting students in Tanjungpinang need to be improved. Other research conducted by Alfian et al. (2024) and Kholidah (2016) also shows that observing skills dominate over inferring and predicting skills. Therefore, science learning in schools needs to integrate with students' science process skills through various learning strategies (Abdjul et al., 2022; Doyan et al., 2021; Lestari et al., 2023; Siahaan et al., 2021; Siregar et al., 2023). Innovation in teaching materials and learning media is also needed to improve students' observing, inferring, and predicting skills (Amelia et al., 2022; Astuti et al., 2018; Susilawati et al., 2016; Waluyo & Nuraini, 2021).

The skills of observing, inferring, and predicting have a very close and sequential relationship in the scientific thinking process (Lukman et al., 2023; Rezba et al., 2021). These three skills form an interconnected series, where the quality of one skill directly affects the effectiveness of the others. Accurate and detailed observation becomes an essential foundation that provides rich data for making precise conclusions. When students can make careful observations, they can

identify important patterns and relationships, which in turn enables them to make more accurate inferences.

The relationship between observation and prediction is also highly significant. Systematic and repeated observational data helps students identify patterns that can be used to make predictions. Experience in observing similar phenomena enhances students' ability to understand variables that influence an event, thus increasing the accuracy of their predictions. Meanwhile, accurate inference serves as an important bridge between observation and prediction, helping students understand the crucial cause-and-effect relationships for making accurate projections or predictions (Oktafiani et al., 2017). These three skills form a mutually reinforcing cycle, where good observation leads to accurate inference, which then enables precise prediction. When predictions are verified through new observations, this can lead to improved inference, which in turn enables more focused observation and more accurate prediction. This reinforcement cycle demonstrates the importance of developing these three skills in a balanced and integrated manner.

As with most scientific research, this study has its limitations. First, it employs a cross-sectional design, which provides only a snapshot of students' observing, inferring, and predicting skills at a specific point in time, without capturing their long-term development. Another limitation lies in the instruments used, which focus primarily on quantitative aspects and have not fully explored the qualitative dimensions of these skills. Additionally, differences in school conditions and facilities, particularly those related to accreditation levels, may have influenced the results. Therefore, further research is needed to conduct a more in-depth assessment of other factors that contribute to these skill differences.

Conclusion

Based on the description and analysis of the data, it can be concluded that the observing with an average interval score of 13.52, inferring by 5.49 and predicting by 1.93. The study's findings allow for the conclusion that the students' observing, inferring, and predicting skills are in the medium category. This indicates the potential for further development that can still be optimized. Essentially, these three skills form a mutually reinforcing cycle, where good observation leads to accurate inference, which then enables precise prediction. When predictions are verified through new observations, this can lead to improved inference, which in turn enables more focused observation and more accurate prediction. Therefore, targeted quality improvement programs and greater resource support are needed to enhance learning quality, especially in science education and the implementation of various learning strategies and innovation of teaching materials in science subjects is needed to improve students' skills. Future research is expected to incorporate qualitative instruments and explore other factors contributing to observing, inferring, and predicting skills.

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Author Contributions

The primary author was heavily involved in data collection and writing the article. The secondary author provided valuable input throughout the research process.

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Conflicts of Interest

The authors declare no conflict of interest related to the publication of this article.

References

Abdjul, T., Katili, N., Kurniasari, S., & Yunus, M. (2022). The Effect of the Application of PhET-Assisted Ryleac Model on Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(5), 2216–2223. https://doi.org/10.29303/jppipa.v8i5.2235

Addis, E. A., & Powell-Coffman, J. A. (2018). Student and Faculty Views on Process of Science Skills at a Large, Research-Intensive University. *Journal of College Science Teaching*, *47*(4), 72–82. https://doi.org/10.2505/4/jcst18_047_04_72

Akbar, J. S., Dasna, I. W., & Wonorahardjo, S. (2019). The Effect of Guided Inquiry-Based Practicum Learning and Prior Knowledge on Learing Outcomes and Science Process Skills of High School Students on Solubility and Solubilty Products. *Jurnal Pendidikan Sains*, *7*(3), 80–84. https://doi.org/10.17977/jps.v7i3.12521

Akbariah, N., Artika, W., Pada, A. U. T., Safrida, S., & Abdullah, A. (2023). STEM-Based Learning Process Analysis of Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 943–951. https://doi.org/10.29303/jppipa.v9i2.2912

Alfian, M. A., Parno, P., Wisodo, H., & Khamis, N. (2024). The Influence of the 9E Learning Cycle with A STEM Approach on Students' Science Process Skills in Static Fluid Topics. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 9012–9019. https://doi.org/10.29303/jppipa.v10i11.8916

Amelia, N., Leksono, S. M., & Resti, V. D. A. (2022). Deveopment of Student Worksheet Based on Science Process Skills and Air Pollution Themes to Grow Critical Thinking Ability in Junior High School Students. *Jurnal Pena Sains*, *9*(2), 48–56. https://doi.org/10.21107/jps.v9i2.14076

Astuti, I. A. D., Putra, I. Y., & Bhakti, Y. B. (2018). Developing Practicum Module of Particle Dynamics Based on Scientific Methods to Improve Students' Science Process Skills. *Scientae Educatia: Jurnal Pendidikan Sains*, *7*(2), 183–196. https://doi.org/10.24235/sc.educatia.v7i2.2513

Aswar, M. A., Patandean, A. J., & Herman. (2019). Studi Keterampilan Proses Sains Fisika Peserta Didik SMAN Se-Kabupaten Jeneponto. *Jurnal Sains dan Pendidikan Fisika (JSPF)*, *15*(3), 43–52. https://doi.org/10.35580/jspf.v15i3.13497

Basuki, F. R., Jufrida, J., Kurniawan, W., Devi, I. P., & Fitaloka, O. (2019). Tes Keterampilan Proses Sains: Multiple Choice Format. *Jurnal Pendidikan Sains (JPS)*, *7*(2), 101–111. https://doi.org/10.26714/jps.7.2.2019.9-19

Chen, D., Fitriani, R., Maryani, S., Rini, E. F. S., Putri, W. A., & Ramadhanti, A. (2021). Deskripsi Keterampilam Proses Sains Dasar Siswa Kelas VIII SMP pada Materi Cermin Cekung. *PENDIPA Journal of Science Education*, *5*(1), 50–55. https://doi.org/10.33369/pendipa.5.1.50-55

Darmaji, D., Kurniawan, D. A., Parasdila, H., & Irdianti, I. (2018). Description of Science Process Skills' Physics Education Students at Jambi University in Temperature and Heat Materials. *The Educational Review*, *2*(9), 485–498. http://dx.doi.org/10.26855/er.2018.09.005

Deehan, J., MacDonald, A., & Morris, C. (2024). A Scoping Review of Interventions in Primary Science Education. *Studies in Science Education*, *60*(1), 1–43. https://doi.org/10.1080/03057267.2022.2154997

Doyan, A., Susilawati, S., & Hardiyansyah, A. (2021). Development of Natural Science Learning Tools with Guided Inquiry Model Assisted by Real Media to Improve Students' Scientific Creativity and Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 15–20. https://doi.org/10.29303/jppipa.v7i1.485

Fatonah, S., & Prasetyo, Z. K. (2014). *Pembelajaran Sains*. Yogyakarta: Penerbit Ombak.

Haerani, H., Arsyad, M., & Khaeruddin, K. (2023). Development of Experiment-Based Physics Worksheets in Science in Developing Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 292–298. https://doi.org/10.29303/jppipa.v9i1.2609

Hasanah, H. (2016). Teknik-teknik Observasi Sebuah Alternatif Metode Pengumpulan Data Kualitatif Ilmu-Ilmu Sosial). *At-Taqaddum*, *8*(1), 21–46. https://doi.org/10.21580/at.v8i1.1163

Hunegnaw, T., Hailegebreal, T. D., Getahun, D. A., & Atlabachew, M. (2024). Students' Science Process Skills Mastery Through Virtual Experiments in Chemical Kinetics Concepts. *Reflective Practice*, 1–18. https://doi.org/10.1080/14623943.2024.2440174

Idul, J. J. A., & Caro, V. B. (2022). Does Process-Oriented Guided Inquiry Learning (POGIL) Improve Students' Science Academic Performance and Process Skills? *International Journal of Science Education*, *44*(12), 1994–2014. https://doi.org/10.1080/09500693.2022.2108553

Istiyono, E. (2020). *Pengembangan Instrumen Penilaian dan Analisis Hasil Belajar Fisika dengan Teori Tes Klasik dan Modern* (2nd ed.). Yogyakarta: UNY Press.

Jusuf, N., Wijaya, A. R., & Dasna, I. W. (2021). The Effect of Project Based Learning (PJBL) Learning Model on Students' Science Process Skills on Colloidal Topic. *Jurnal Pendidikan Sains*, *9*(3), 100–103. https://doi.org/10.17977/jps.v9i3.15096

Kholidah, L. N. (2016). *Pengembangan Instrumen Penilaian Practical Skills IPA Peserta Didik SMP*. Yogyakarta: Universitas Negeri Yogyakarta.

Lestari, A. K., Fitriani, A., & Kusnadi, K. (2023). Application of STEM-Integrated Guided Inquiry Model to Improve Science Process Skills of Junior High School Learners on Human Respiratory System Material. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11078–11084. https://doi.org/10.29303/jppipa.v9i12.5845

Lukman, I. R., Unaida, R., Setiawaty, S., & Sabrina, N. (2023). Implementation of Digital-Based Authentic Assessment to Assess Observing, Inferring and Predicting Skills in Prospective Chemistry Teachers. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1948–1953. https://doi.org/10.29303/jppipa.v9i4.2731

Maizaliani, C. R., Muhibbuddin, M., Syukri, M., Saminan, S., Nurmaliah, C., Evendi, E., & Herliana, F. (2024). Utilizing Visual Teaching Materials to Assist Students in Science Subjects Improves Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 2162–2169. https://doi.org/10.29303/jppipa.v10i4.6815

Maranan, V. M. (2017). *Basic Process Skills and Attitude Toward Science: Inputs to an Enhanced Students's Cognitive Performance*. Laguna State Polytechnic University.

Mariana, E., & Kinasih, A. (2021). Improving Science Process Skills and Concept Understanding Through Field Study of Class VII.1 Student. *Jurnal Pendidikan Sains (JPS)*, *9*(2), 193–200. https://doi.org/10.26714/jps.9.2.2021.193-200

Martin, D. J. (2016). *Elementary Science Methods: A Constructivist Approach (What's New in Education)*.

USA: Wadsworth.
OECD. (2023). *PISA 2022 Results: Factsheets-Indonesia*. Paris: OECD Publishing.
Oktafiani, P., Subali, B., & Edie, S. S. (2017). Pengembangan Alat Peraga KIT Optik Serbaguna (AP-KOS) untuk Meningkatkan Keterampilan Proses Sains. *Jurnal Inovasi Pendidikan IPA*, *3*(2), 189–200. http://dx.doi.org/10.21831/jipi.v3i2.14496
Ong, E. T., Ramiah, P., Ruthven, K., Salleh, S. M., Yusuff, N. A., & Mokhsein, S. E. (2015). Acquisition of Basic Science Process Skills Among Malaysian Upper Primary Students. *Research in Education*, *94*(1), 88–101. https://doi.org/10.7227/RIE.0021
Ongowo, R. O., & Indoshi, F. C. (2013). Science Process Skills in the Kenya Certificate of Secondary Education Biology Practical Examinations. *Scientific Research*, *4*(11), 712–717. http://dx.doi.org/10.4236/ce.2013.411101
Ozdeniz, Y., Aktamis, H., & Bildiren, A. (2023). The Effect of Differentiated Science Module Application on the Scientific Reasoning and Scientific Process Skills of Gifted Students in a Blended Learning Environment. *International Journal of Science Education*, *45*, 827–849. https://doi.org/10.1080/09500693.2023.2175627
Prasojo, P. (2016). Pengembangan Perangkat Pembelajaran IPA Berbasis Inkuiri Terbimbing untuk Meningkatkan KPS dan Berpikir Kritis. *Jurnal Pendidikan Matematika dan Sains*, *4*(2), 130–141. https://doi.org/10.21831/jpms.v4i2.12944
Purwanti, A. (2017). Keefektifan Metode Eksperimen Terhadap Keterampilan Proses dan Hasil Belajar IPA Siswa Kelas VIII SMP. *Jurnal Pendidikan Matematika dan Sains*, *5*(1), 77–88. https://doi.org/10.21831/jpms.v5i1.13458
Rezba, R. J., Sprague, C., Matkins, J. J., & Mcdonnough, J. T. (2021). *Learning and Assessing Science Process Skills* (5th ed.). New York: Kendall Hunt Publishing Company.
Rosanti, D. F., Diantoro, M., Kusairi, S., & Yulianti, E. (2023). The Influence of the 5E Learning Cycle Strategy with a Link Map on Students' Mastery of Physics Concepts and Science Process Skills. *Jurnal Pendidikan Sains*, *11*(1), 27–34. https://doi.org/10.17977/jps.v11i12023p027
Rusni, R., Bahri, A., & Ristiana, E. (2020). Profil Sikap Ilmiah Siswa Kelas IV SD Inpres Ana Gowa dan SD Negeri Tombolo K. *Jurnal Sainsmat*, *9*(1), 82–90. https://doi.org/10.35580/sainsmat91141962020
Safaah, E. S., Muslim, M., & Liliawati, W. (2017). Teaching Science Process Skills by Using the 5-Stage Learning Cycle in Junior High School. *Journal of Physics: Conference Series*, *895*. https://doi.org/10.1088/1742-6596/895/1/012106
Safahi, L., Akbar, B., Selvianah, A., Astuti, Y., & Anugrah, D. (2019). Perbedaan Keterampilan Proses Sains Biologi Siswa Sekolah Menengah Atas Berdasarkan Tingkat Akreditas Sekolah. *Bioeduscience*, *3*(2), 106–111. https://doi.org/10.29405/j.bes/32106-1113651
Saleh, A. R., Hala, Y., & Ramadani, R. (2024). Journeying Through Inquiry-Based Learning: A Focus on Science Process Skills. *Jurnal Sainsmat*, *13*(1), 113–125. https://doi.org/10.35580/sainsmat131613092024
Santoso, A., & Prodjosantoso, A. K. (2020). Pengembangan Instrumen Integrated Assessment antara Keterampilan Proses Sains dan Penguasaan Konsep IPA untuk Mengukur Aspek Kognitif Proses. *Jurnal Pendidikan Matematika dan Sains*, *8*(2), 93–102. https://doi.org/10.21831/jpms.v8i2.21225
Setiawaty, S., Fatmi, N., Rahmi, A., Unaida, R., Fakhrah, Hadiya, I., Muhammad, I., Mursalin, M., Muliana, M., Rohantizani, R., Alchalil, A., & Sari, R. P. (2018). Science, Technology, Engineering, and Mathematics (STEM) Learning on Student's Science Process Skills and Science Attitudes. *Proceedings of MICoMS 2017 (Emerald Reach Proceedings Series)*, *1*, 575–581. https://doi.org/10.1108/978-1-78756-793-1-00036
Setyawarno, D., & Kurniawati, A. (2022). Science Learning Oriented to Higher Order Thinking in Digital Era. *AIP Conference Proceedings*, *2600*(1). https://doi.org/https://doi.org/10.1063/5.0112450
Sheeba, M. N. (2013). *An Anatomy of Science Process Skills In The Light of The Challenges to Realize Science Instruction Leading To Global Excellence in Education*.
Siahaan, K. W. A., Lumbangaol, S. T. P., Marbun, J., Nainggolan, A. D., Ritonga, J. M., & Barus, D. P. (2021). Pengaruh Model Pembelajaran Inkuiri Terbimbing dengan Multi Representasi terhadap Keterampilan Proses Sains dan Penguasaan Konsep IPA. *Jurnal Basicedu*, *5*(1), 195–205. https://doi.org/10.31004/basicedu.v5i1.614
Siregar, N. F., Sriyati, S., & Amprasto, A. (2023). The Implementation of Dialogic TeachingThrough Concept Cartoon Worksheets to Improve High School Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 5816–5826. https://doi.org/10.29303/jppipa.v9i8.3767
Susilawati, S., Neneng, L., & Miranda, Y. (2016). Pengembangan Modul Pembelajaran Biologi untuk Meningkatkan Keterampilan Proses Sains dan Hasil Belajar Siswa SMA Kelas X. *EduSains*, *4*(2), 104–114. https://doi.org/10.23971/eds.v4i2.513
Waluyo, E., & Nuraini, N. (2021). Development of Instructional Design Project-Based Learning Model Integrated Science Process Skills to Improve Science Literacy. *Jurnal Pendidikan Sains (JPS)*, *9*(1), 104–112. https://doi.org/10.26714/jps.9.1.2021.104-112

Yuberti, Y., Kartika, I., Pratiwi, I., Riyadi, B., Latifah, S., & Pilia, Q. M. (2020). An Analysis of Generic Science Skills as 21st-Century Skills for Preservice Physics Teacher at UIN Raden Intan Lampung. *Journal of Physics: Conference Series*, *1796*, 1–9. https://doi.org/10.1088/1742-6596/1796/1/012043

Yulihapsari, D., Anif, S., & Muhibbin, A. (2023). Science Process Skills in Implementation Food Test Practicum in Junior High School. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 714–720. https://doi.org/10.29303/jppipa.v9i2.3020

Yuliskurniawati, I. D., Noviyanti, N. I., Mukti, W. R., Mahanal, S., & Zubaidah, S. (2019). Science Process Skills Based on Genders of High School Students. *Journal of Physics: Conference Series*, *1241*, 1–8. https://doi.org/10.1088/1742-6596/1241/1/012055