JPPIPA 9(12) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Students' Science Process Skills through Practicum Method on Cell Material for Class XI

Ilvayani[1], Lilan Dama[1*], Aryati Abdul[1]

[1] Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Indonesia.

Received: May 29, 2023
Revised: November 20, 2023
Accepted: December 20, 2023
Published: December 31, 2023

Corresponding Author:
Lilan Dama
lilandama@ung.ac.id

DOI: 10.29303/jppipa.v9i12.4061

Abstract: This study aims to determine students' science process skills through practicum method on cell material for class XI IPA of SMA Negeri 1 Tapa. The research method used quasi-experimental, a posttest-only non-equivalent control group design. Data collection was performed through observation sheets and test questions. The data analysis used is the t-test. According to research conducted in class XI IPA 1 using the practicum method, students in the experimental class had an average science process skill score of 79%. In contrast, students in the control class, which did not use the practicum method, had an average of 55%. Therefore, the science process skills of students in the experimental class are higher than those in the control class due to the use of the practicum method. Teachers guide students in activities during the learning process by asking open-ended questions that spark a discussion. Students are therefore required to be active, creative, and able to collaborate during the learning process to meet the learning objectives and understand the concepts being taught easily.

Keywords: Practicum; Science process skills

Introduction

Education is a conscious and planned effort planned to create an atmosphere of learning and learning process so that learners actively develop their potential, so that education has an important role important role in a person's life which will later become a provision in face the challenges of the future future challenges that are greater and full of competition (Muja & Darwis, 2021). Education is a means to develop knowledge, skills, attitudes, and habits of students with national education (Budiarti et al., 2022). Education is a skill that is passed down from one generation to the next with efforts to increase knowledge and training through teaching and learning efforts (Ernawati et al., 2021).

The goal of education is to create a learning environment where students can reach their full potential, with a particular emphasis on helping students develop those potentials and abilities that will benefit society, the country, and the state. One of the expected abilities is the science learning process skills (Elvanisi et al., 2018). Education leads learners or human beings towards changes in behavior in the form of knowledge, attitudes, morals, and social can live independently as an individual creature and live in society well as a social being. social being(Nawir et al., 2019).

Science learning based on process skills guides students to find their knowledge which is intended to help them more easily develop a deeper comprehension of material about nature. In addition, the implementation of this learning entails scientific methods, which call for observation skills, problem-solving, hypothesis formulation, data collection, analysis, evaluation, and drawing conclusions (Purwati et al., 2016). In essence, science learning not only trains students to understand the concept of the material provided but also trains them to develop useful skills that make it easier to solve problems by practicing practical activities (Haka et al., 2020). One of the sciences that need to be learned with process skills is biology, the materials that exist in biology have a close conceptual relationship (Fitriana et al., 2019).

Basically, science learning aims to prepare students to be responsive to their environment, because because

How to Cite:
Ilvayani, Dama, L., & Abdul, A. (2023). Students' Science Process Skills through Practicum Method on Cell Material for Class XI. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11302–11310. https://doi.org/10.29303/jppipa.v9i12.4061

by learning biology students can learn to understand natural phenomena that occur in their environment (Tias & Octaviani, 2018). The benefits obtained from scientific literacy can be used in school life and everyday life

Biology learning is part of the foundation of science and technology, which has significantly changed various aspects of life on Earth (Hamidah, 2022). There are many ways for a teacher to deliver subject matter that can make students feel happy, including is by using the right model and approach in learning activities learning activities (Kiay, 2018).

Due to the fact that it covers various concepts of life, studying science, including biology, has a comparatively broad field of study. Concepts in biology are closely related to everyday life, so connecting biology concepts with everyday life makes learning more meaningful than just memorizing. Thus, teachers must have the ability to develop learning, one of which is by applying the practicum method. In addition to listening to the teacher's explanation, they can observe and directly feel the phenomenon that occurred. Learning phenomena can run more effectively when students come into direct contact with the object they are studying.

Practicum in a learning activity learning activities can improve students' critical thinking skills critical thinking skills of students in learning Biology concepts. Practical activities require students to have the ability in process skills. Achievement of process skills in learning is influenced by the ability and background of the teacher as an agent of change in teaching something that is not yet known (Amin et al., 2021).

Studying science as a process is also known as science process skills (SPS) (Mardaleni, 2019). The process skills focus on students to be actively involved in finding concepts so that learning will be meaningful (Abidah & Yuliani, 2020). Science process skills involve skills that require high categories of complex skills such as observation, problem formulation, hypothesis development, variable identification and variable operational definition, research planning with appropriate procedures, analysis, interpretation, inference and presentation of research results (Khotimah et al., 2021) . Science process skills are very important for students to master this is because the development of science is very fast so it is no longer possible to teach facts and concepts. science progresses so fast that it is no longer possible to teach facts and concepts to students (Putri et al., 2022).

Science process skill is one of the skills that can be improved when studying biology, especially on cell structure material. Since biology incorporates direct experience as a learning experience, it, therefore, demands science process skills so that one may comprehend the stages or actions being carried out. In essence, students already have science process skills, such as asking questions, investigating, observing, classifying, predicting, interpreting, and communicating (Manu et al., 2018). However, these abilities can be seen as less than optimal because learning methods need to be applied to generate these abilities (Manu et al., 2018).

Science process skills are physical and mental skills that should be possessed by scientists to acquire and develop knowledge. In addition, science process skills also involves intellectual skills, manual, and social skills that students use in the learning process (Fitriana et al., 2019). Science process skills have a relationship with student cognition development (Nugraha et al., 2019). In this skill, students will required for how to get new knowledge from the initial knowledge that they have previously obtained by them before (Uliya & Muchlis, 2022). Science process skills are fundamental competencies needed to mastering science (Syazali & Ilhamdi, 2022).

Science process skills in line with the principle of learning principle of constructivism, where students discover and construct their own their own knowledge. To be able to construct the knowledge knowledge, then in the learning process science learning process, it is expected that students' science process skills develop. From several components that influence on the development of students' science process skills in learning, one of of which is the method that used by the teacher when teaching (Senisum, 2021).

Science process skills also have shortcomings that are not rarely found in students at school. This is This can be seen, for example, from practicum activities, they can only measure with one particular measuring instrument. with one particular measuring instrument only and do not use other measuring instruments. other measuring instruments (Damarwulan, 2020). The science process skills were an approach to learning, where students get the opportunity to interact in real objects to find their concepts (Sholikhah et al., 2019). Process skills or scientific methods are part of the study of science. This section will briefly review related to the nature of science process skills, types of science process skills, assessment techniques for science process skills, and the implementation of science assessment for Science Process Skills (Kurniawati, 2021).

Indirectly, it can be It can be said that science process skills are also a form of approach to teaching science that is based on the process of observation that has been in the process of teaching science which is based on the observation process that has been done by a scientist (Suleman et al., 2020). Students may engage in a more active role in experiencing and comprehending a variety of learning processes by using science process skills, which makes it easier to increase responsibility in learning. For instance, the learning of cell material will be easily comprehended when students have the science process skills. Moreover, problem-solving activities carried out by students are supported by feelings of curiosity about the surrounding environment through experiments and observations. These conditions require science process skills as well.

One of the most commonly employed cognitive skills is the ability to process scientific information. People who are unable to employ science process skills will find it difficult to function in daily life because they are used in both education and daily life. The science process skills need to be developed through direct experiences as learning experiences. Through direct experience, students can better appreciate the process or learning activities that are being carried out (Nirwana et al., 2016).

Measurement of some science process skills is still required. Several Gorontalo schools have integrated learning, however, it has not been completely assessed yet. Likewise, accredited schools have yet to measure science process skills, so the percentage of students' science process skills is uncertain. These skills need to be measured because they are crucial in understanding concepts in depth and solving problems.

Based on observations made at SMA Negeri 1 Tapa, students are found to experience tremendous challenges in developing science process skills. Therefore, the existence of science skills can make it easier for students to increase the stage of the learning process. In order to help students develop their science process skills, all related-problems need to be addressed. This can be accomplished through practicum method since it can aid students in expanding their knowledge by putting them in close proximity to tangible learning resources and providing assistance that helps them uncover topics on their own. Moreover, cell observation will present a challenge to students in their ability to improve their science process skills because this concept can be learned by students in a concrete or tangible way through direct observation. Practicum can be defined as a series of learning activities that allow students to apply skills or practice an activity. Students to apply skills or practice an activity (Purwanti & Heldalia, 2022).

Furthermore, the results of observations made at SMA Negeri 1 Tapa revealed that teacher-students interactions in the learning of cell material were still relatively low. This situation resulted from the fact that students only took notes and listened to the teachers explanations. As a result, the teacher becomes the center of knowledge, and students are passively learning. According to the background of the problem, students' science process skills, especially in cell material at SMA Negeri 1 Tapa, need to be measured because they are closely related to student learning outcomes. Thus, the researcher wants to reveal the percentage of students' science process skills through observation and test assessment questions from the practicums that have been carried out. This is what motivated the researcher to conduct a study entitled "Students' Science Process Skills through Practicum Method on Cell Material for Class XI of SMA Negeri 1 Tapa."

Methods

The type of research used is quasi-experimental research, a method in which a control group is added to the experimental group to explore the causal (cause and effect) relationship between two factors that the researcher deliberately brought in. The design used is a post-test-only Non-equivalent Control Group Design, which includes a pre-test and a post-test. This study uses a practicum method to be applied in XI IPA 1, which resembles the pretest-posttest control group design, but the subjects are not randomly selected. The experimental group is educated through cell structure process practicum method, while the control group is through direct learning or without the practicum.

Table 1. Research Design

Class	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_3
Control	O_2	C	O_4

Where:
X : Treatment with a practicum in the experimental class
C : Treatment without practicum in the control class
O_1 : *Pre-test* of experimental class
O_2 : *Pre-test* of control class
O_3 : *Post-test* of experimental class
O_4 : *Post-test* of control class

The design used was a pretest-posttest control group design through a pre-test before treatment and a post-test after treatment. The results of the treatment can be more valid because it provides a comparison of the conditions before and after being given treatment. The design is shown in the table 1.

Result and Discussions

Description of Experiment Class Results

The researcher applies science process skills in the experimental class during the learning process. To determine how the practicum technique affects students' science process skills, students were given pre- and post-tests at the beginning and end of the meeting, respectively. The following are the results of the test in table 2.

Table 2. Description of Experimental Class Pre-test and Post-test Results

Data	Experimental	
	Pre-test	Post-test
Lowest Score	25	64
Highest Score	60	90
Average	39.37	79.89
Standard Deviation	7.257	18.580

Source: processed in 2023

Based on the table 2, there are differences in the acquisition of scores before and after the science process skills approach is applied which is shown in the highest, lowest, and average scores for all students. This condition explains an increase after learning is carried out by applying the science process skills approach.

Description of Control Class Results

The researcher applies the science process skills approach in the control class without carrying out practicum in the learning process. Students took a pre-test at the beginning of the meeting and a post-test at the end to determine whether there had been any differences from the experimental class. The following are the results of the test in table 3.

Table 3. Description of Control Class Pre-test and Post-test Results

Data	Control	
	Pre-test	Post-test
Lowest Score	26	55
Highest Score	55	75
Average	40.85	67.63
Standard Deviation	7.998	15.193

Source: processed in 2023

Based on the table above, there are differences in the acquisition of scores before and after the science process skills approach is applied that is shown in the highest, lowest, and average scores for all students. These conditions explain that there are changes in the implementation of learning.

Results of Observation of Aspects of Overall Science Process Skills

The observation data were obtained from students' science process skills during the learning stage from the first to the third meetings. The learning activities of the experimental group applied science process skills through practicum activities, while the control group applies the science process skills (SPS) without practicum activities. The students' science process skills were measured by using Science Process Skills Assessment Sheet which had been declared valid and reliable (Wijayaningputri et al., 2018). The results of the science process skills observations of both experimental and control groups are shown in the table.

Table 4. Recapitulation of science process skills (Science Process Skills) Observation Data

SPS Aspects	Percentage (%)	
	Control	Experimental
Observing	36%	72%
Classifying	36 %	75 %
Interpreting	62 %	70%
Predicting	64%	73%
Asking Questions	69%	77%
Formulating Hypotheses	62%	78%
Planning Experiments	37%	78%
Conducting Experiments	62%	81%
Using Tools and Materials	29%	88%
Applying Concepts	73%	80%
Communicating	75%	98%
Average	55%	79%

Source: Processed in 2023

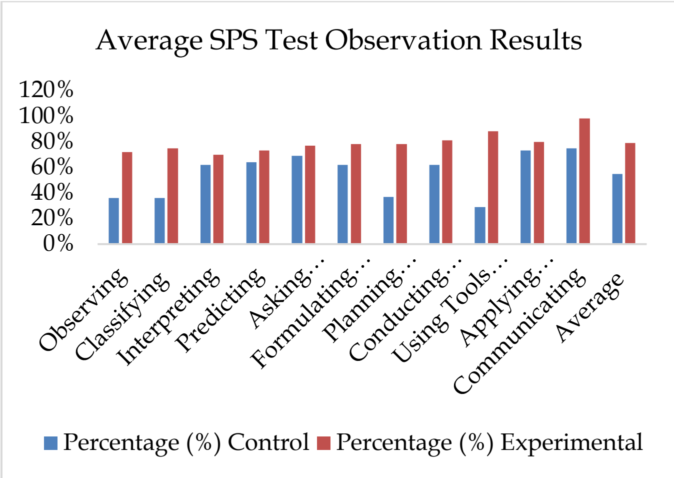

Figure 1. Data Recapitulation Results of Observation of Science Process Skills

The figures above show differences in students' science process skills (SPS) between the experimental class and the control class in cell material for each indicator of science process skills. In the experimental class, the highest indicator was obtained, namely the communication indicator with a percentage of 98% in the excellent category, while the lowest indicator was interpreting which obtained 70% in the sufficient category. Meanwhile, the control class obtained the highest science process skills (SPS) on the communication indicator with a percentage value of 75% in the sufficient category, whereas the lowest indicator was using tools and materials which obtained a percentage value of 29% in the significantly less category. Therefore, the percentage value in the experimental class is greater than the control class.

Observation of Students' Science Process Skills (SPS).

The results of three observers' observations of students' performance on 11 science process skills indicators using the practicum method revealed a range of good percentages. This condition explains that through this method, students are guided to improve science process skills starting at the lowest level, namely carrying out observations to the communicative level. Science process skills can be trained through the introduction of habits and continuous training. The role of the teacher in guiding his students and applying learning methods is significant in developing the science process skills.

The results of observing science process skills activities in ongoing learning explain that the learning method involves students so that they are actively involved in learning. Students' science process skills results were obtained from 11 indicators found in both the experimental and control class, with the highest percentage in the experimental being communicating indicator, and the lowest percentage being interpreting indicator. Meanwhile, the highest science process skills percentage found in the control class was the indicator of communicating, and the lowest was an indicator of using tools and materials.

Table 4 shows the first indicator, namely the observing indicator. The experimental class obtains a percentage of 72% which fall in the good category. In comparison, the control class obtains a percentage of 36% under the very poor category. In learning activities to measure science process skills observing indicators, the teacher assigns students to observe directly through the optimal use of the senses on the structure of plant and animal cells.

The second is the grouping or classifying indicator, which is the ability to identify similarities and differences in observing objects and classify them according to specific characteristics, purposes, or interests; table 4 shows that the experimental class obtains a percentage of 75% in the sufficient category, while the control class obtains 36% in the very poor category. This shows the need to improve the quality of students in the classification process (Mutmainnah et al., 2019).

The third is the interpreting indicator, which is the ability to ask students to interpret in the form of writing, pictures, tables, and graphics. From these observations, the percentage of science process skills in the experimental class was 70%, which was in the sufficient category. In contrast, it was 62% in the control class, which was in the sufficient category.

The fourth is the predicting indicator, which is an indicator of skills in anticipating or predicting or regarding all things that can happen in the future according to specific patterns or trends or correlations between facts, concepts, and principles in science (Septanningtyas, 2020). Based on the results of observations, the experimental class obtains a percentage of 73% in the sufficient category. However, the control class obtains a percentage of 64% in the sufficient category as well. In practicum activities, students predict the structure of cells in plants and animals. Dimyati (2006) stated that predictive ability is the ability to anticipate or predict future events based on predictions of specific trend patterns or correlations between facts, concepts, and scientific principles.

The fifth is the asking question indicator which aims to stimulate students to think independently at the synthesis level to solve the problems they are facing effectively (Siwa et al., 2013). The experimental class obtains a percentage of 77% which fall in a good category, whereas the control class obtains a percentage of 69% in the sufficient category. This reveals that students are able to communicate what they want to know, yet they still need to improve in compiling questions related to a scientific phenomenon.

The sixth is formulating a hypothesis indicator, which aims to teach students to ask questions or provide quick answers to what they observe, then prove it through practicum (Sumarti et al., 2018). The experimental class obtains a percentage of 78% which fall in the good category, whereas the control class obtains 62% in the sufficient category. These conditions explain that students can formulate hypotheses from an experiment. This skill can be appropriately implemented if students understand the concept underlying a problem (Handayani, 2016).

The seventh is the planning of experiments. The indicator of science process skills (SPS) for experimental planning is the next step from the observation stage (Sumarti et al., 2018). The experimental class obtains 78% which falls in the good category, while the control class obtains a percentage of 37% in the very poor category. This condition explains that in the control class, students have not been able to plan experiments well; it is different in the experimental class that they have been able to do so.

Practical activities in the laboratory presents a learning environment that can help students build knowledge, develop critical thinking skills and psychomotor skills. This activity also have great potential in promoting positive attitudes and providing opportunities to develop cooperation and communication skills. However, the facts on the ground shows that the implementation of practicum in laboratory is less than optimal. Research results showed that teachers tend to conduct practicum activities in large groups of 4 - 5 students, this causes only only some of the group members who work while the others are spectators. Lack of equipment and materials, negative attitudes students, passivity and lack of cooperation are also the cause of low students' science process skills. science process skills. Teachers also prefer practicum activities in groups, rather than individual because it requires less preparation of tools and tools and materials and make it easier to clean cleaning and easier to discipline and control students. discipline and control students. This causes a lack of science skills and students' science skills and knowledge because studens need hands-on experience experience to acquire science process skills (Supatmi, 2022).

The eighth is conducting experiments. This is an activity carried out to describe students' science process skills against various indicators, especially on the cell structure practicum in this study. The evaluation carried out is whether or not the student can carry out ongoing experiments through the use of predetermined concepts. The experimental class obtains a percentage of 81% which fall in the good category, while the control class obtains 62% in the sufficient category.

The ninth is using equipment and materials indicators which are measured through accuracy indicators in using equipment and measurements, reading and determining measuring equipment, and carrying out experiments through the measured practicum. Based on observations, the experimental class obtains a percentage of 88% which fall in the excellent category, whereas the control class obtains a percentage of 29% in the very poor category. This condition explains that students' expertise in using equipment and materials in the experimental class is already good. The more often you learn to use specific tools or materials, the more skilled you are at using them.

The tenth indicator is applying concepts which aim to determine students' expertise in applying the concept to the experiment being carried out; the observer team observes the activities of the students regarding whether each group can provide new insights on the results of their research. From the observations, the experimental class obtains a percentage of 80% which fall in the good category, while the control class obtains a percentage of 73% in the sufficient category. This condition explains that students can use the concepts they already understand to solve the problems.

The last indicator of students' science process skills is communication. Communication skills mean that students are able to read and classify information in the form of graphics and diagrams, describe empirical data in the form of graphs, tables, or diagrams, explain experimental results, and compile and present reports clearly (Septantiningtyas. 2020). The experimental class obtains a percentage of 98% which fall into the excellent category. In comparison, the control class obtains a percentage of 75% in the sufficient category. The results explain that students can carry out their activities properly and systematically based on the learning stages. This condition is marked by activities that each group of students engages in, such as informing the phases of work when completing practicums and by oral presentations of reports on the outcomes of their observations in front of the class. From the data above, it can be concluded that practicum-based learning can improve science process skills in all aspects observed (Ginting et al., 2021).

Conclusions

Students' science process skills (SPS) in the experimental class scored higher than the control class due to the implementation of the practicum method. During the learning process, the teacher initiates dialogues with the students by posing open-ended questions, which forces them to participate actively and come up with innovative solutions. This method helps students grasp new concepts and accomplish learning objectives. The findings revealed that in the learning of cell material, the communication indicator is the highest science process skills indicator in the experimental class, with an average percentage of 98%, and the communication indicator is the highest science process skills indicator in the control class as well, with an average percentage of 75%.

Acknowledgements

Thank you to the supervisor, principal, biology teacher, and students of class XI IPA SMA Negeri 1 Tapa who have been actively involved in helping carry out the research.

Author Contribution

Conceptualization, Aryati Abdul, Lilan Dama.; data curation, Ilvayani; formal analysis, Ilvayani.; funding acquisition, Ilvayani.; investigation, Ilvayani; methodology, Lilan Dama, Aryati Abdul; project administration, Lilan Dama, Aryati Abdul and Ilvayani.; software, Ilvayani.; supervision, Lilan Dama.; validation, Lilan Dama.; visualization, Lilan Dama, Aryati Abdul and Ilvayani.; writing –original draft, Ilvayani.; writing –review & editing, Ilvayani. All authors have read and agreed to the published version of manuscript

Funding

This researchreceived no external funding.

Conflicts of Interest

The authors declare no conflict of interest

References

Abidah, S. D., & Yuliani, Y. (2020). The Validity and Practicality of Student Worksheet Based on Guided Discovery to Practice Integrated Science Process Skills in Class XII Enzyme Submaterials. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *9*(3), 422–432. https://doi.org/10.26740/bioedu.v9n3.p422-432

Amin, N., Mulyadi, M., Kamal, S., Ahadi, R., Alfida, A., & Usman, A. (2021). Peningkatan Pengetahuan Dan Keterampilan Proses Sains Berbasis Praktikum Melalui Reproduksi Vegetatif Budidaya Tanaman Pada Siswa Sma Negeri 1 Pulo Aceh Kabupaten Aceh Besar. *BIOTIK: Jurnal Ilmiah Biologi Teknologi Dan Kependidikan*, *8*(2), 186. https://doi.org/10.22373/biotik.v8i2.8040

Budiarti, R. S., Kurniawan, D. A., & Rohana, S. (2022). A Comparison by Gender: Interest and Science Process Skills. *Journal of Education Research and Evaluation*, *6*(1), 88–97. https://doi.org/10.23887/jere.v6i1.37723

Damarwulan, R. A. (2020). Hubungan Pelaksanaan Praktikum dan Keterampilan Generik Sains terhadap Hasil Belajar Peserta Didik. *BIOEDUSCIENCE: Jurnal Pendidikan Biologi Dan Sains*, *4*(1), 56–65. https://doi.org/10.29405/j.bes/4156-653610

Dimyati., & Mudjiono. (2006). *Belajar dan Pembelajaran*. PT. Rineka Cipta. Jakarta.

Elvanisi, A., Hidayat, S., Nurmala Fadillah, E., Jendral Yani, J. A., Palembang, K., Selatan, S., & Author, C. (2018). Analisis keterampilan proses sains siswa sekolah menengah atas. *Jurnal Inovasi Pendidikan IPA*, *4*(2), 245–252. https://doi.org/10.21831/jipi.v4i2.21426

Ernawati, M. D., Asrial, Perdana, R., Septi, S. E., & Rahmi. (2021). Jurnal Pendidikan Progresif Middle School Science Subject in Indonesia. *Jurnal Pendidikan Progresif*, *1*(2), 258–274. https://doi.org/10.23960/jpp.v1

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

Ginting, D. E., Sahal, M., Education, P., & Riau, U. (2021). Development of Physics Lab-Based Dynamic Electrical Learning Module to Practice Science Process Skills Students for Grade IX SMP. *Jurnal Geliga Sains (JGS): Jurnal Pendidikan Fisika, 9*(2), 83-91. Retrieved from https://jgs.ejournal.unri.ac.id/index.php/JGS/article/view/7953

Haka, N. B., Pratiwi, V. D., Anggoro, B. S., & Hamid, A. (2020). Analisis Keterampilan Proses Sains Dan Self Regulation Biologi Kelas XI : Pengaruh Model Auditory, Intellectually dan Repatition (AUDI-IR). *Journal Of Biology Education*, *3*(1), 16. https://doi.org/10.21043/jobe.v3i1.6922

Hamidah, A. (2022). Keterampilan Proses Sains Mahasiswa Biologi Melalui Penerapan Model Pembelajaran Inkuiri Terbimbing pada Praktikum Fisiologi Hewan. *BIOEDUSAINS: Jurnal Pendidikan Biologi Dan Sains*, *5*(1), 295–303. https://doi.org/10.31539/bioedusains.v5i1.3590

Handayani, S. M. (2016). Peningkatan Keterampilan Proses Sains Pada Pembelajaran Biologi Melalui Penerapan Model Bounded Inquiry Lab. *Bioedukasi*, *9*(2), 49–54. Retrieved from https://jurnal.uns.ac.id/bioedukasi/article/download/4218/3644

Khotimah, K., Hastuti, U. S., Ibrohim, & Suhadi. (2021). Developing microbiology digital handout as teaching material to improve the student's science process skills and cognitive learning outcomes. *Eurasian Journal of Educational Research*, *95*(95), 80–97. https://doi.org/10.14689/EJER.2021.95.5

Kiay, M. I. (2018). Meningkatkan Keterampilan Proses Sains Siswa dengan Metode Eksperimen Pada Mata Pelajaran IPA di SMP Negeri 4 Gorontalo. *JPs: Jurnal Riset Dan Pengembangan Ilmu Pengetahuan*, *3*(2), 138–147. Retrieved from https://ejurnal.pps.ung.ac.id/index.php/JPS/article/view/295

Kurniawati, A. (2021). Science Process Skills and Its Implementation in the Process of Science Learning Evaluation in Schools. *Journal of Science Education Research*, *5*(2), 16–20. https://doi.org/10.21831/jser.v5i2.44269

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

Mardaleni. (2019). Model Pembelajaran Inkuiri Terbimbing Terhadap Keterampilan Proses Sains (Science process skills) Peserta Didik Pada Materi Sistem Koordinasi. *Jurnal Pembelajaran Biologi: Kajian Biologi Dan Pembelajarannya*, *6*(2), 2613–9936.

Muja, M., & Darwis, A. N. (2021). Pengaruh Pelaksanaan Praktikum Terhadap Keterampilan Generik Sains Siswa Sma Negeri 5 Maros. *Binomial*, *4*(2), 140–153.

https://doi.org/10.46918/bn.v4i2.1057

Mutmainnah, S. N., Padmawati, K., Puspitasari, N., & Prayitno, B. A. (2019). Profil Keterampilan Proses Sains (Science process skills) Mahasiswa Profile of Science Process Skills in Biology Education Students in Terms of Academic Ability (Case Study At a University in Surakarta). *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, *3*(1), 49–56. Retrieved from https://jurnal.um-palembang.ac.id/dikbio/article/view/1687

Nawir, M., Khaeriyah, & Syamsuriyawati. (2019). Efektivitas model pembelajaran kooperatif tipe student facilitator and explaining terhadap hasil belajar metematika peserta didik kelas viii SMP Negeri 18 Lau Kabupaten Maros. *EQUALS: Jurnal Ilmiah Pendidikan Matematika, 2*(2), 100-108. http://ejournals.umma.ac.id/index.php/equals/article/view/422

Nirwana, H. D., Haryani, S., & Susilogati, S. (2016). Penerapan Praktikumberbasis Masalah Untuk Meningkatkan Keterampilan Proses Sains Siswa. *Jurnal Inovasi Pendidikan Kimia, 10*(2), 1788–1797. Retrieved from https://journal.unnes.ac.id/nju/index.php/JIPK/article/view/9532

Nugraha, M. G., Utari, S., Saepuzaman, D., Solihat, F. N., & Kirana, K. H. (2019). Development of basic physics experiments based on science process skills (SPS) to enhance mastery concepts of physics pre-service teachers in Melde's law. *Journal of Physics: Conference Series*, *1280*(5). https://doi.org/10.1088/1742-6596/1280/5/052075

Purwanti, E., & Heldalia, H. (2022). Korelasi Keterampilan Proses Sains Dengan Kemampuan Berpikir Kritis Siswa Pada Materi Pemantulan Pada Cermin Datar. *Journal Evaluation in Education (JEE)*, *1*(4), 143–148. https://doi.org/10.37251/jee.v1i4.146

Purwati, R., Prayitno, B. A., & Sari, D. P. (2016). Penerapan model pembelajaran inkuiri terbimbing pada materi sistem ekskresi kulit untuk meningkatkan keterampilan proses sains siswa kelas XI SMA. *Proceeding Biology Education Conference*, *13*(1), 325–329. Retrieved from https://jurnal.uns.ac.id/prosbi/article/view/5736

Putri, W. A., Astalini, A., & Darmaji, D. (2022). Analisis Kegiatan Praktikum untuk Dapat Meningkatkan Keterampilan Proses Sains dan Kemampuan Berpikir Kritis. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(3), 3361–3368. https://doi.org/10.31004/edukatif.v4i3.2638

Senisum, M. (2021). Keterampilan Proses Sains Siswa Sma Dalam Pembelajaran Biologi. *Jurnal Pendidikan Dan Kebudayaan Missio*, *13*(1), 76–89. https://doi.org/10.36928/jpkm.v13i1.661

Septantiningtyas, N., Hakim, M. R. L., dan Rosmila, N. (2020). *Konsep Dasar Sains 1*. Klaten: Lakeisha.

Sholikhah, M., Prastowo, T., & Prabowo. (2019). The Effectiveness of Learning Materials of Inquiry Models to Practice Science Process Skills in Simple Harmonic Motion's Matter. *Journal of Physics: Conference Series*, *1417*(1). https://doi.org/10.1088/1742-6596/1417/1/012077

Siwa, I. B., Muderawan, I. W., & Tika, I. N. (2013). Pengaruh Pembelajaran Berbasis Proyek dalam Pemebalajaran Kimia terhadap Keterampilan Proses Sains ditinjau dari Gaya Kognitif Siswa. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha*, *3*(3), 1–13. Retrieved from https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ipa/article/view/794

Suleman, S. M., Laenggeng, A. H., Sabran, M., & Agni, R. (2020). Meningkatkan keterampilan proses sains pada asisten laboratorium pendidikan biologi FKIP UNTAD melalui bimbingan praktikum lapangane ekologi. *Jurnal Kreatif Online*, *8*(4), 22–29. Retrieved from http://jurnal.untad.ac.id/jurnal/index.php/JKTO/article/view/16948

Sumarti, S. S., Nuswowati, M., & Kurniawati, E. (2018). Meningkatkan Keterampilan Proses Sains Melalui Pembelajaran Koloid Dengan Lembar Kerja Praktikum Berorientasi Chemo-Entrepreneurship. *Phenomenon : Jurnal Pendidikan MIPA*, *8*(2), 175–184. https://doi.org/10.21580/phen.2018.8.2.2499

Supatmi, S. (2022). Peningkatan Keterampilan Proses Sains Melalui Praktikum Kimia Berbasis Skala Mikro Materi Stoikiometri. *JRPK: Jurnal Riset Pendidikan Kimia*, *12*(1), 47–57. https://doi.org/10.21009/jrpk.121.07

Syazali, M., & Ilhamdi, M. L. (2022). Keterampilan Proses Sains Mahasiswa Pada Topik Keanekaragaman Hayati Melalui Implementasi Laboratorium Alam Dan Spada Unram. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *12*(1), 19–26. https://doi.org/10.24929/lensa.v12i1.174

Tias, I. W. U., & Octaviani, S. (2018). the Effect of Using the Project Based Learning Model on Process Skills and Science Literation Skills. *Jhss (Journal of Humanities and Social Studies)*, *2*(2), 25–30. https://doi.org/10.33751/jhss.v2i2.905

Uliya, N. H., & Muchlis, M. (2022). Implementasi Model Pembelajaran Inkuiri Terbimbing Berbasis Google Classroom Terhadap Keterampilan Proses Sains

Peserta Didik. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(1), 1083–1093. https://doi.org/10.31004/edukatif.v4i1.2134

Wijayaningputri, A. R., Widodo, W., & Munasir, M. (2018). *Effectiveness of Guided-Inquiry Model to Train Science Process Skills of Senior High School Students*. *157*(Miseic), 59–63. https://doi.org/10.2991/miseic-18.2018.15