



# The Influence of POGIL and MFI Models on Science Literacy and Science Process Skills for Junior High School

Sirry Alvina<sup>1</sup>, Mellyzar<sup>1\*</sup>, Syarifah Rita Zahara<sup>2</sup>, Masrina<sup>1</sup>, Sella Afrianti<sup>2</sup>

<sup>1</sup>Department of Chemistry Education, Universitas Malikussaleh, North Aceh, Indonesia

<sup>2</sup>Department of Physics Education, Universitas Malikussaleh, North Aceh, Indonesia

Received: September 9, 2022

Revised: October 4, 2022

Accepted: October 24, 2022

Published: October 31, 2022

Corresponding Author:

Mellyzar

[mellyzar@unimal.ac.id](mailto:mellyzar@unimal.ac.id)

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DOI: [10.29303/jppipa.v8i4.2121](https://doi.org/10.29303/jppipa.v8i4.2121)

**Abstract:** This study aims to determine how the influence of the POGIL model on the ability of the science process and scientific literacy of students, in addition to knowing how the MFI model affects science process skills and scientific literacy of students and the comparison of POGIL and MFI models on science process skills and scientific literacy of Lhokseumawe City Junior High School students. This research uses an approach to quantitative research. The population of this research is the seventh-grade students of SMP in Lhokseumawe city. The research sample taken is SMPN students Arun, SMPN 1 Lhokseumawe, and SMPN 2 Lhokseumawe every 3 schools that consist of 2 experimental classes (POGIL and MFI models) and 1 control class (conventional) with a total of 9 classes. The research instrument used is a test question for knowing students' literacy skills, practicum guide sheets, and observation sheets to determine students' science process skills. In the class with the POGIL model, the average value of scientific literacy ability is 32.27, and science process skills are 81.32. In class with the MFI model, the average value of science literacy skills is 26.84, and process skills science 88.71. While the control class has an average value of scientific literacy ability of 12.77 and science process skills of 68.54. Based on Test Test output Statistics data of students' scientific literacy and science process skills are known as the value of asymp. Sig. (2-tailed) of  $0.00 < 0.05$ , it can be concluded that the POGIL model has a significant effect on students' scientific literacy and science process skills. The results for the MFI class scores of students' scientific literacy skills and science process skills, because of the Asymp value. Sig.  $(0.000 < (0.05))$  so that learning with the MFI model affects the scientific literacy ability and science process skills of students. Classes taught with POGIL and MFI models with Asymp grades. Sig.  $(0.099 > (0.05))$  means that there is no significant difference in students' scientific literacy skills between students who are taught with the POGIL model and students who are taught with the MFI model but there is a significant difference in science process skills of students with POGIL and MFI models, where the MFI model students' science process skills higher than the POGIL model.

**Keywords:** POGIL; MFI; Scientific Literacy; Science Process Skills

## Introduction

Science and technology are developing very rapidly in the era of the industrial revolution 4.0. In this era, technology and innovation are spreading faster and more widely than in previous eras. A society that can embrace technological innovation is the main key to the progress of a country (Philbeck & Davis, 2018). Therefore, preparing a generation that is qualified and able to master technological developments is important which is important for the future of the country. The 21st

century is the century in which the countries of the world can interact with each other as if they had no geographical barriers. Science and technology are increasing rapidly. Globalization is rampant. Resources can flow freely and openly. The emergence of foreign workers who are free to enter a country, the number of imported products that affect the production system actions in the country, and so on. For this reason, Indonesia must have the competencies needed in the 21st century which can be obtained through the learning process.

## How to Cite:

Alvina, S., Mellyzar, M., Zahara, S.R., Masrina, M., & Afrianti, S (2022). The Influence of POGIL and MFI Models on Science Literacy and Science Process Skills for Junior High School. *Jurnal Penelitian Pendidikan IPA*, 8(4), 2201-2209. <https://doi.org/10.29303/jppipa.v8i4.2121>

Among these competencies, the first is science process skills. Science process skills are an important skill in carrying out scientific activities (Elfeky, Abdellah Ibrahim Mohammed Masadeh & Elbyaly, 2020; Inayah et al., 2020; Ramayanti et al., 2017). Science process skills play a role in helping students develop their minds, participate actively, and build a sense of responsibility in the process of gaining or developing knowledge (Atmojo, 2012; Haryadi & Pujiastuti, 2020; Ongowo & Indoshi, 2013; Safaruddin et al., 2020). Science process skills can also help students to understand concepts (Prasasti & Listiani, 2018).

Science process skills are important for building knowledge and being applied in learning. Building knowledge is not only obtained through theory but can also be obtained from experimental activities or activity-based learning. This is where science process skills can emerge because these skills contain scientific methods or steps in seeking, gaining new knowledge, and developing existing knowledge. If students are directly trained to build their knowledge, that knowledge will last a long time in them (Suryaningsih, 2017; Yulkifli et al., 2019). The application of learning by improving science process skills is very important because of the rapid development of science, so teaching students verbally is no longer possible, students must be trained to seek knowledge, and discover new knowledge and concepts.

Science process skills are believed to improve scientific literacy (Handayani et al., 2018). Scientific literacy skills for students are needed. The literature in the field of science education also shows that scientific literacy is increasingly being accepted and valued by educators as an expected learning outcome (Rahayu, 2017). Scientific literacy is defined as the ability to engage in science-related issues and think about science as a wise citizen (OECD, 2016). Scientific literacy is needed to understand scientific issues, the benefits, and risks of science (Fasasi, 2017), and with scientific literacy skills can understand social and environmental problems faced by society in this modern era, especially those that rely on knowledge and technology (Turiman et al., 2012).

Scientific literacy can be measured through the PISA (Program for International Student Assessment) organized by the OECD (Organization for Economic Cooperation and Development) every three years. The results of the PISA study for the average scientific literacy ability of Indonesian students from 2000, 2003, 2006, 2009, 2012, 2015, and 2018 were 393, 395, 393, 385, 375, 403, and 396 (OECD, 2019). The results of students' scientific literacy are still in the low category because the scores obtained are below the average PISA completeness score. This indicates that Indonesian students have not been able to understand the concepts and processes of science and have not been able to apply

the scientific knowledge they have learned in everyday life (Sutrisna, 2021). The dimensions of scientific literacy presented by the Program for International Student Assessment (PISA) consist of (1) context in the form of personal (self, family, and peer group), local/national (society), and global (life around the world). PISA divides the fields of science application into three groups, namely life and health, earth and the environment, and technology (2) competencies in the form of explaining scientific phenomena, evaluating and designing scientific investigations, interpreting scientific data and evidence, (3) scientific knowledge which consists of three dimensions, namely content knowledge, procedural knowledge, and epistemic knowledge (Nofiana & Julianto, 2018; OECD, 2016).

Factors that cause students' low scientific literacy include the selection of textbooks, misconceptions, non-contextual learning, and students' reading ability (Fuadi et al., 2020). The low scientific literacy ability of students shows that the students' higher-order thinking skills and cognitive strategies are still low. Higher-order thinking skills and cognitive strategies cannot be taught directly but must be trained in the learning process. Therefore, the factors causing the low scientific literacy ability of students can come from teachers, quality of learning and teaching, students, facilities and infrastructure, etc.

Teachers have a considerable influence on learning outcomes. The low scientific literacy ability of students can be caused because teachers tend to not integrate the concept of learning with its application in everyday life. This causes students to often have difficulty in solving the problems presented in the problem because they are not accustomed to linking the knowledge that has been obtained with real-life situations.

One solution to increase the ability of students' science process skills and scientific literacy is to apply the inquiry learning model which is one of the recommended learning models in the 2013 curriculum (Mardianti et al., 2020). Inquiry models that promote inquiry strategies and process skills are the *Process Oriented Guided Inquiry Learning* (POGIL) and *Modified Free Inquiry* (MFI) models.

POGIL is a process-oriented and student-centered inquiry learning model, designed with small groups interacting with instructors or teachers as facilitators (Cahayningrum et al., 2017). POGIL is a heterogeneous group learning model with the aim that students' mastery of the material can be improved to develop thinking, communication, discussion, analysis, and evaluation skills to realize the students' learning process correctly. The syntax of the POGIL learning model is direction, exploration, concept discovery, application, and closing (Alamanda, 2015).

The MFI learning model is one type of inquiry learning model. MFI has the characteristics of the teacher as a facilitator, and motivator, and provides the

necessary assistance to ensure the smooth learning process of students (Aqib & Murtadlo, 2016). Where the teacher only gives problems, students are asked to solve them through observation, exploration, or through research procedures. The teacher acts as a motivator, and resource person, and is tasked with assisting when students need it. With this model, students are directed to explore, design, and perform experiments.

The influence of the inquiry learning model to improve science process skills and scientific literacy has been widely carried out by academics around the world, including in Indonesia. Research results reveal different values expressed in terms of education level, media used, type of inquiry, and subjects used. Based on this, researchers are interested in knowing how the POGIL model influences students' science process skills and scientific literacy, in addition to knowing how the MFI model influences students' science process skills and scientific literacy and the comparison of POGIL and MFI models on science process skills and scientific literacy. Lhokseumawe City Junior High School students.

**Method**

This research uses a quantitative research approach. Quantitative research is based on the philosophy of positivism which emphasizes objective phenomena that are studied quantitatively or carried out using numbers, statistical processing, structures, and controlled experiments (Nana, 2010). The type of quasi-experimental research is research to see the effect of certain treatments on others under controlled conditions (Sugiyono, 2014). The research design used a posttest control group design. The research design is shown in Table 1.

**Table 1.** Research Design

Group	Treatment	Posttest
Control class	X <sub>0</sub> SPS	SL
Experiment 1	X <sub>1</sub> SPS	SL
Experiment 2	X <sub>2</sub> SPS	SL

- X<sub>0</sub> : Control class
- X<sub>1</sub> : POGIL Model
- X<sub>2</sub> : MFI Model
- SPS : Science Process Skill
- SL : Science Literacy

The population of this research is the seventh-grade students of SMP in Lhokseumawe City in the Academic Year of 2022/2023. The samples taken were students of SMPN Arun, SMPN 1 Lhokseumawe, and SMPN 2 Lhokseumawe. A total of 9 classes. There are three classes for each school, consisting of a control class taught by *direct* instruction and an experimental class taught by POGI and MFI. The sampling technique was carried out in two stages, the determination of the school sample and then continued with the determination of the class sample school sampling technique was carried out by convenience sampling, and the class sample was taken using a random sampling technique with the class as the subject being randomized. The total sample is 251 students.

The data obtained from this study are data in the form of scores of scientific literacy skills and science process skills. The data from this study were analyzed using parametric statistics, namely the independent sample t-test for data with normal distribution, and non-parametric statistics, namely the Mann-Whitney U-Test for data not normally distributed. Data analysis was carried out with the help of the SPSS program.

The hypotheses model on students' scientific literacy skills; 2) there is an effect of the MFI model on students' scientific literacy skills; 3) there is an effect of the POGIL model on students' science process skills; 4) there is an effect of the MFI model on students' science process skills; 5) there are differences in the scientific literacy skills of students who are taught using the POGIL model and students who are taught using the MFI model; 6) there are differences in the scientific literacy skills of students who are taught using the POGIL model and students who are taught using the MFI model.

The research instruments used were test questions to determine students' literacy skills, practicum guide sheets, and observation sheets to determine students' science process skills in practicum implementation. The test questions are in the form of descriptions arranged based on a scientific literacy grid. The questions are structured in a personal, local, and global context.

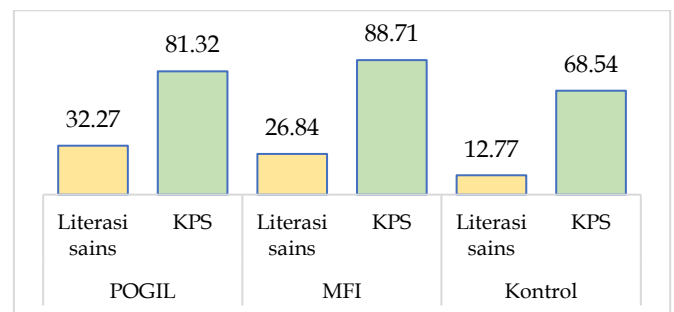
**Table 2.** Science Literacy Ability Test Grid Concepts of Acids, Bases, and Neutrals

Unit	Context	Knowledge	Competency	Scientific Literacy Achievement	Number Questions
Apple tree	Personal - environment	Content	Explaining phenomena scientifically	Explain the types of acidic, base, and neutral soils based on environmental conditions	1.1
		Procedural	Procedural preparing scientific inquiry	Propose a method for determining acid, base, and neutral soil types using natural indicators	1.2
		Epistemic	Evaluating scientific inquiry	Selecting methods used to measure soil pH	1.3

Unit	Context	Knowledge	Competency	Scientific Literacy Achievement	Number Questions
Gastric pains	Personal - health	Epistemic	Interpret data and facts scientifically	Analyzing acidity levels based on environmental conditions	1.4
		Procedural	Explaining phenomena scientifically	Apply the concept of neutralizing acids and bases to soil	1.5
		Content	Explaining phenomena scientifically	Explain the effects of the excess stomach based on the nature of the acid	2.1
		Procedural	Explaining phenomena scientifically	Explain the concept of neutralizing a strong acid with a strong base	2.2
		Epistemic	Evaluating scientific inquiry	Analyze acids and bases contained in food	2.3, 2.4
Bee sting	Personal - health	Content	Explaining phenomena scientifically	Explain the concept of neutralizing the acid with a base	3.1
		Epistemic	Explaining phenomena scientifically	Give an example of a base in household ingredients as a solution to neutralize acids	3.2
		Epistemic	Interpret data and facts scientifically	Analyzing the principle of neutralization of acids in the health sector	3.3
Acid rain	Global - environment	Content	Explaining phenomena scientifically	Analyze the properties of strong acids and weak acids based on the effects of acid rain	4.1
		Procedural	Preparing scientific inquiry	Propose a method to determine the acid strength of rainwater	4.2
		Procedural	Evaluate and compile scientific inquiry	Analyzing the properties of strong acids based on the effects of acid rain on the environment	4.3
		Content	Interpret data and facts scientifically	Explain the nature of strong acids based on the effect of acid rain on the environment	4.4
		Epistemic	Evaluate and compile scientific inquiry	Analyze the causes of acid rain due to motor vehicle emissions.	4.5

### Result and Discussion

The results of the analysis on the value of scientific literacy and science process skills showed that there was a difference in the average score between the experimental class and the control class. The average value of science literacy ability and science process skills of students in the experimental class is higher than the average value of students' science literacy and science process skills in the control class. In the class with the POGIL model, the average value of scientific literacy ability is 32.27, and science process skills are 81.32. In the class with the MFI model, the average value of science literacy skills is 26.84, and science process skills are 88.71. While the control class has an average value of scientific literacy ability of 12.77 and science process skills of 68.54. The comparison of the average value of scientific literacy skills and science process skills in the experimental class and the control class can be seen in Figure 1.



**Figure 1.** The average value of science literacy ability and science process skills  
*Influence of the POGIL Model on Students' Science Literacy and Science Process Skills*

Prerequisite tests in the form of normality and homogeneity tests were carried out on students' science literacy and science process skills scores before testing the hypothesis. The results of the normality test with the Kolmogorov-Smirnov test on the value of scientific literacy obtained a significance value (Sig.) = 0.009 for the experimental class taught by the POGIL model and (Sig.) = 0.000 for the control class. Because of the value of Sig. (0.009) < (0.05) and Sig. (0.000) < (0.05), it can be concluded that the students' scientific literacy scores are not normally distributed. The results of the normality test of students' process skills can be seen in Table 3.



**Table 3.** The results of the normality test of students' scientific literacy scores.

Class	Kolmogorov-Smirnov		
	Statistic	df	Sig.
POGIL	0.139	87	0.009
Control	0.162	83	0.000

Based on the results of this test, the hypothesis test was carried out using nonparametric statistics by using the Mann-Whitney U-Test. The results of the U-test obtained the Asymp. Sig. (2-tailed) = 0.000. Because of the value of Asymp. Sig. (0.000) < (0.05) then the research hypothesis is accepted, meaning that there is a difference in students' scientific literacy skills between students who are taught using the POGIL model and students who are taught by direct learning. From these results, it can be concluded that learning with the POGIL model affects students' scientific literacy skills. The results of the Mann-Whitney U-Test test students' scientific literacy scores can be seen in Table 4.

**Table 4.** The results of the Mann-Whitney U-Test test scores students' scientific literacy through the POGIL and control.

	Value
Mann-Whitney U	1443.500
Wilcoxon W	4846.500
Z	-6.762
Asymp. Sig. (2-tailed)	0.000

The average score of students' scientific literacy skills for classes taught with POGIL is 32.27 and 12.77 is low for the control class. In general, this happens due to several reasons, namely students' reading ability, misconceptions, and non-contextual learning. The big dimensions of scientific literacy in its measurement are the scientific process, science content, and the context of science application (Nofiana & Julianto, 2018). The average score of students' scientific literacy skills in the class taught by the POGIL model was higher than in the control class. The results of this study are in line with research results that state that the use of the POGIL model in teaching and learning activities has a positive influence on students' scientific literacy skills (Devitri & Djamas, 2019; Mellyzar et al., 2022; Nikmah & Ellianawati, 2019; Volz, 2019). Based on the output of Test Statistics, it is known that the Asymp. Sig. (2-tailed) of  $0.00 < 0.05$ , it can be concluded that there is a significant effect of the POGIL model on the scientific literacy of grade 7 students at SMP Lhokseumawe City. The difference in students' scientific literacy abilities where the POGIL model is higher is understandable because POGIL learning is process-oriented and student-centered in active learning that uses cooperative learning and guided inquiry activities to develop knowledge, analysis, problem-solving, metacognition,

and individual responsibility compared to learning direct transfer of knowledge from teacher to student.

The results of the normality test for the value of students' science process abilities obtained data that were not normally distributed for both the control class and the experimental class taught with the POGIL model. The results of the normality test can be seen in Table 5.

**Table 5.** The results of the normality test of the value of process skills POGIL class and control class students sain science

Class	Kolmogorov-Smirnov		
	Statistic	df	Sig.
POGIL	0.182	87	0.000
Control	0.166	83	0.000

Hypothesis testing was continued by using nonparametric statistics, namely the Mann-Whitney U-Test.

**Table 6.** The results of the Mann-Whitney U-Test value students' science process skills.

	Value
Mann-Whitney U	1617.500
Wilcoxon W	5103.500
Z	-6.242
Asymp. Sig. (2-tailed)	0.000

U-test results obtained the Asymp. Sig. (2-tailed) = 0.000. Because of the value of Asymp. Sig. (0.000) < (0.05) then the research hypothesis is accepted, meaning that there are differences in students' science process skills between students who are taught using the POGIL model and students who are taught using conventional learning. From these results, it can be concluded that the POGIL model has an effect on students' process skills. This is in line with previous research which states that POGIL can improve science process skills for students (Alatas & Fachrunisa, 2018; Idul & B. Caro, 2022; Zamista & Kaniawati, 2015). The difference in process skills between the experimental class and the control class can be caused because, in the inquiry model learning, learning activities are not only in the form of knowledge transfer from teachers and students. However, students were conditioned to be actively involved in learning activities.

*The effect of the MFI Model on Science Literacy and Science Process Skills Students*

A normality test was carried out on the value of students' scientific literacy skills who were taught with the MFI model and the control class before testing the hypothesis. The results of the normality test with the Kolmogorov-Smirnov test on the value of scientific literacy obtained a significance value (Sig.) = 0.000 for the experimental class taught by the MFI model and the

control class. So it can be said that the data is not normally distributed so the hypothesis testing uses the Mann-Whitney U-Test.

From figure 1, the average score of science literacy skills of class students taught by MFI is still relatively low, namely 26.84. The average score is higher than the control class, which is 12.77 and there are differences in students' scientific literacy skills between students who are taught using the MFI model and students who are taught by direct learning. This study is in line with previous research that the MFI model provides better results on students' scientific literacy skills (Gunawan et al., 2019; Heleri et al., 2019). The results of the Mann-Whitney U-Test test scores of students' scientific literacy skills, because of the Asymp score. Sig. (0.000) < (0.05). From these results, it can be concluded that learning with the MFI model affects students' scientific literacy skills. The results of the Mann-Whitney U-Test test on the value of students' process skills can be seen in Table 7.

**Table 7.** The results of the Mann-Whitney U-Test value students' scientific literacy.

	Value
Mann-Whitney U	1519.500
Wilcoxon W	4922.500
Z	-5.913
Asymp. Sig. (2-tailed)	0.000

In addition to students' scientific literacy ability which is influenced by the MFI model, students' scientific processability can also be influenced by the MFI model. From the results of the Mann-Whitney test on the value of science process skills, the Asymp value is obtained. Sig. (0.000) < (0.05). From these results, it can be concluded that learning with the MFI model affects students' science process skills. This research is in line with previous research which states that the MFI-based practicum method can improve students' science process skills. The results of science process skills to assess students' abilities in observing, classifying, communicating, hypothesizing, and applying concepts during practicum, experimental class students applying the MFI model, have a percentage that is higher than the control class (Marta et al., 2018).

**Table 8.** The results of the Mann-Whitney U-Test value MFI class students' science process skills and class control.

	Value
Mann-Whitney U	652.000
Wilcoxon W	4138.000
Z	-8.949
Asymp. Sig. (2-tailed)	0.000

*Comparison of POGIL and MFI on Science Literacy Ability and Science Process Skills of Students*

MFI and POGIL affect students' scientific literacy skills. This is because students experience learning that places students at the center of learning. The problems presented by both POGIL and MFI challenge students to solve. POGIL and MFI according to the characteristics of acid-base and neutral materials. The average score of students' scientific literacy skills taught using the POGIL model is 32.27 and the MFI is 26.84. For the average class ability given the POGIL model is better than the MFI model, this is because through POGIL students are more focused on determining problem-solving that produces new concepts for students, because it is more focused, students will be able to understand the concept better and have no difficulty in solving problems. problem-solving.

While in the MFI model learning, a little freedom is given to students, in the selection of tools and materials for solving problems according to the student worksheets (LKS) given. However, this freedom still confuses some students of Lhokseumawe City Junior High School. For diligent students, they will take advantage of this freedom enthusiastically and look enthusiastic about conducting electrolysis experiments, but for less diligent children, just stay silent, even show a lazy attitude, or tend to chat with friends. So that some students are still not able to gain mastery of the concept as a whole. This is in line with previous research that the POGIL method gives better results than MFI from student learning outcomes (Budiasa & Nyeneng, 2013), but the difference in learning outcomes of these two models is not very significant. Find out the differences between the POGIL and MFI models on students' scientific literacy skills through the Mann-Whitney U-Test, which can be seen in Table 9.

**Table 9.** The results of the Mann-Whitney U-Test test scores students' scientific literacy through the POGIL and MFI

	Value
Mann-Whitney U	3001.000
Wilcoxon W	6241.000
Z	-1.650
Asymp. Sig. (2-tailed)	0.099

Based on the results of the Mann-Whitney U-Test, the Asymp value was obtained. Sig. (2-tailed) = 0.099. Because of the value of Asymp. Sig. (0.099 > (0.05) then the research hypothesis is rejected, meaning that there is no significant difference in students' scientific literacy skills between students taught with the POGIL model and students taught with the MFI model. This is because these two series of learning emphasize the thinking process critically and analytically to find and decide for themselves the answer to a question in question. In line with previous research which concluded that both

models promote investigative strategies and values and attitudes and process skills, for example: observing, collecting and organizing data, identifying and controlling variables, formulating and testing hypotheses, explanations, and concluding (Widyaningsih et al., 2012). In the aspect of science process skills, the value of Asymp Sig. ( $0.000 < (0.05)$ ) means that the research hypothesis is accepted, meaning that there is a significant difference in students' science process skills. taught with the POGIL model L and MFI models. The average value of students' science process skills with the MFI model is higher than in the POGIL model.

## Conclusion

This study aims to determine how the influence of the POGIL model on students' science process skills and scientific literacy, in addition to knowing how the MFI model influences students' scientific process skills and scientific literacy and the comparison of POGIL and MFI models on science process skills and science literacy for junior high school students. Lhokseumawe City. The average value of students' scientific literacy and science process skills in the experimental class was higher than in the control class. In the class with the POGIL model, the average value of scientific literacy ability is 32.27, and science process skills are 81.32. In the class with the MFI model, the average value of science literacy skills is 26.84, and science process skills are 88.71 While the control class has an average value of scientific literacy ability of 12.77 and science process skills of 68.54. Based on the output of the Test Statistics of scientific literacy data and students' science process skills are known that the Asymp score. Sig. (2-tailed) of  $0.00 < 0.05$ , it can be concluded that there is a significant effect of the POGIL model on students' scientific literacy and science process skills. The results for the MFI class scores of students' scientific literacy skills and science process skills, are because of the Asymp score. Sig. ( $0.000 < (0.05)$ ). From these results, it can be concluded that learning with the MFI model affects students' scientific literacy skills and science process skills. Classes taught with POGIL and MFI models with Asymp grades. Sig. ( $0,099 > \alpha (0,05)$ ) then the research hypothesis is rejected, meaning that there is no significant difference in students' scientific literacy skills between students taught with the POGIL model and students taught with the MFI model. This is because these two series of learning emphasize critical and analytical thinking processes to find and decide for themselves the answer to a problem.

## Acknowledgments

The researcher would like to thank Malikussaleh University through the Institute of Research and

Community Service which has funded this research through grants research and community service sources of funds for Universitas Malikussaleh PNBPN 2022.

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