# SCIENTIFIC LITERACY SKILLS OF PRE-SERVICE BIOLOGY TEACHERS BASED ON SPENT YEARS IN UNIVERSITY AND CONTRIBUTED FACTORS

**Widi Cahya Adi[1*], Muhammad Saefi[2], Ndzani Latifatur Rofi'ah[3]**
[1) 3)] Fakultas Sains dan Teknologi, Universitas Islam Negeri Walisongo Semarang
[2)] Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Malang
email: widicahyaadi@walisongo.ac.id

***Abstract***
*Apart from the importance of scientific literacy for the pre-service teachers as the key to success in becoming a teacher who can teach and make literate students, not many studies have revealed the contributing factors, especially the learning experience students. This study aims to measure the level of scientific literacy skills of pre-service students and contributed factors. One hundred and five students at state Islamic universities in Indonesia participated in this study. The data were collected in three stages. First, the level of scientific literacy skills using the Test of Scientific Literacy (TOSLS). Two students with the highest and lowest abilities in each batch were interviewed. Finally, the semester learning plan (RPS) and practicum instructions are reviewed. The mean was used to describe the level of scientific literacy skills, and one-way ANOVA to test differences in skill between the four groups based on the spent year in university. Data obtained from interviews and analysis were analyzed using content analysis techniques. As a result, pre-service biology teachers have a "medium" level of scientific literacy skills. There was a difference between the four groups with the highest and most significantly different fourth-year students. The primary cause of scientific literacy skills is the student learning experience in terms of learning strategies, assignments, evaluations, and practicums activities that are obtained by pre-service biology teachers. The results suggest the following implications for teaching: faculties must identify scientific literacy skills and carry out learning with learning strategies, assignments, evaluations, and practicum activities that support the growth of scientific literacy abilities of a pre-service biology teacher.*

***Keywords:*** *Scientific Literacy, Preservice Biology Teachers, Contributed Factor*

## 1. INTRODUCTION

Scientific literacy is one of the abilities that must be prepared for the younger generation (Jufrida et al., 2019). Scientific literacy is the capacity to use scientific knowledge, identify problems, draw conclusions based on evidence, and make the right decisions (OECD, 2006). According to Gormally et al (2012) in general scientific literacy skill includes two skills, namely (1) understanding inquiry methods to gain scientific knowledge, (2) the ability to organize, analyze, and interpret quantitative data and scientific information.

The importance of scientific literacy skills intended for humans to be able to overcome problems and make the right decisions in various aspects of life in the future (Gucluer & Kesercioglu, 2012; Jufrida *et al.*, 2019). Preparing the younger generation with good scientific literacy skills can be taught through science education.

Scientific literacy is an important element in science education (Gucluer and Keserclioglu, 2012; Gormally, et al, 2012), so that learning must be oriented towards scientific literacy (Jufrida et al., 2019). Teachers in science education are a very important factor in encouraging scientific literacy of their students (Altun-Yalçn et al., 2011; Fakhriyah et al., 2017).

The results of the scientific literacy survey of Indonesian students based on the results of the mapping by Trends in International Mathematics and Science Studies (TIMSS) in 2015 show the science literacy score of Indonesian students are still in the 45th rank out of 48 countries (Martin & Mullis, 2015). Meanwhile, according to the results of the Programme for International Student Assessment (PISA) conducted by The Organization for

Economic Co-operation and Development (OECD) in 2018, Indonesia ranks 74th out of 79 countries with a score in the science category of 369, well below the OECD average score of 489 (OECD, 2019).

The low scientific literacy of students reflects the weakness of science education in Indonesia. According to Dani (2009), one of the causes of the low scientific literacy of students is the low scientific literacy skills and understanding of the nature of the science of the teacher. Therefore, teachers have a great responsibility in developing students' scientific literacy, so the urgency in preparing pre-service science teachers to have good scientific literacy is a great importance (Cavas et al, 2013; Suwono & Furaidah, 2016). Universities that produce pre-service science teacher must equip students with good scientific literacy so that later they will be able to successfully teach and produce literate students (Maulidia et al, 2018).

A number of research results on the scientific literacy abilities of pre-service science / biology teacher students show that the level of scientific literacy is still unsatisfactory, namely the average ability is at a medium-low level (Saefi, 2017; Suwono et al, 2017; Suwono & Furaida: 2016; Novitasari, 2018). Research on the level of scientific literacy of pre-service science / biology teachers has only stopped at level measurement without any further investigation regarding contributing factors or factors causing it.

The factors that influence scientific literacy according to a number of studies often get mixed results (Cavas et al., 2013). Shaffer et al (2019) reported that student achievement and experience level (based on GPA, Scholastic Aptitude Test (SAT) score, STEM or non-STEM majors, and college year) were significantly correlated with scientific literacy skills. Hidayah et al (2019) also reported that interest in science, learning motivation, teacher strategies in learning, and school facilities can also affect scientific literacy.

Despite the many factors that affect scientific literacy, the factor that can be supported by universities to prepare pre-service science teachers is the application of learning strategies. According to Dragoş and Mih (2015) the integration and implementation of scientific literacy into the curriculum can improve scientific literacy skills. This is also supported by Suwono & Furaidah (2016) and Novitasari (2018) who recommend changes in learning strategies that further improve scientific literacy.

The development of scientific literacy can be done by implementing constructivistic learning strategy (Jufrida et al., 2019). A number of strategies have been reported to improve scientific literacy, including guided inquiry (Ristanto et al., 2017; Adi et al., 2017), Problem Based Learning (De Moraes & Castellar, 2010), Project Based Learning (Hernawati et al., 2019; Tias & Octaviani, 2018).

As explained, there are a number of learning strategies that can be used by lecturers to improve the scientific literacy of pre-service biology / science students, but it should be noted that not all lecturers apply these strategies. This study aims to investigate the level of scientific literacy skills of pre-service biology teacher students, followed by the exploration of contributing factors, particularly the learning experience students receive.

## 2. RESEARCH METHODS

This research was conducted using a survey method with three approaches, namely tests, interviews, and document review with the aim of measuring the level of students’ scientific literacy skills and finding out the causative factors.

### Procedure

This research was conducted in three stages as follows:

***Stage 1 (Test).*** The test aims to measure the scientific literacy level of student biology teacher candidates. The test is carried out by distributing instruments and asking students to work in a maximum of 40 minutes.

***Stage 2 (Interview).*** The interview aims to explore the factors that contribute to scientific literacy. Prior to the interview, permission and approval of the interview time and place were conducted. During the interview, students were informed about the average results of the scientific literacy level of each generation. Next, students are asked questions that are focused on the students' learning experience during lectures.

***Stage 3 (Document Review).*** The document review aims to confirm the results of student interviews regarding the learning designs that have been applied by the lecturer. The review is carried out on the Semester Learning Plan (RPS) document and practicum instructions. Prior to the review, documents were collected by asking permission from the head of the study program and a number of lecturers who were lecturing courses.

**Participants**

Participants in this study were 105 were pre-service biology teacher students at the State Islamic University in Central Java Province. Participants come from different generations, and were selected by random sampling technique. After obtaining the scientific literacy test results, 2 students from each generation were selected to be interview respondents. The selection of respondents was done by using purposive sampling technique, namely selecting students with the best and worst abilities in each generation.

**Instrument**

Scientific literacy level measurement instruments using validated test instruments developed by Suwono & Rofi'ah (2017). The instrument refers to the Test of Scientific Literacy (TOSLS) indicator (Gormally et al, 2012). The test consists of 26 multiple choice items with 9 assessment indicators, namely Scientific Argument, Literature Validation, Scientific Information, Experimental Design, Creating Graphics, Data Interpretation, Problem Solving, Basic Statistics, Inference.

Examples of items from several indicators are as follows.

**Indicator: Experiment Design**

Which of the following statements is a hypothesis?

a. The depth of groundwater in mountainous areas with rare tree conditions is thought to be less than 10 meters
b. The number of farmers who use integrated pest control technology has reached 50% of all farmers in Java
c. Biological tests of liquid waste from textile factories show that concentrations of 5% or more can cause nerve damage in fish
d. The abundance of tilapia fish in Wadul Lahor in 2017 showed a higher abundance than in 2015
e. The number of kidney stone patients in Malang Regency is higher than in Lumajang Regency

**Indicator: Troubleshooting**

A study on life expectancy conducted in the U.S. Using a random sample of 1000 people, it shows that the average life expectancy of women is 80.1 years and 74.9 years for men. One way you can increase the assurance that women are actually living longer than men in the U.S.?

a. If the average life expectancy of women minus the average life of men is positive, then women are indeed living longer
b. If the average life expectancy of men minus the average life of women is negative, then women are indeed living longer.
c. Perform statistical analysis to determine whether women live longer than men.
d. Graphs the average life expectancy of women and men and analyzes it visually.
e. There is no way to increase your assurance that there is a difference between the sexes.

**Indicator: Making Inference**

The FKUI / RSCM student division conducted a study of the prevalence of asthma in junior high school aged children in Central Jakarta in 1995-1996. The results showed that 1296 students aged 11 years 5 months –18 years 4 months, found 14.7% with a history of asthma and 5.8% with recent asthma. Asthma is not a contagious disease, it can be caused by various factors, one of which is heredity. In your opinion, is this statement true?

a. True, asthma is an inherited disease that has been proven from various studies
b. True, asthma is not a contagious disease, but is usually transmitted genetically and is closely related to allergic factors.
c. Wrong, asthma has complications in the form of inflammation or respiratory infections that can be transmitted to people around through the air.
d. Wrong, when people with asthma cough, the asthma virus spreads through the air and is inhaled by healthy people.
e. Wrong, asthma is caused by allergens, as a result the airway narrows, so that the breath feels short.

Structured interview instruments are prepared and focused on questions about student learning experiences, namely about learning strategies, assignments, evaluations, and practicum that are applied during lectures. The document review is done by checking RPS and practicum instructions, which are based on the learning, assignment and evaluation strategies, and practicum written on the document.

Examples of interview questions are as follows.

1. How was the learning strategy experience that your teacher applied during the lecture?
2. What is the level of inquiry level applied in practicum so far?

**Data Analysis**

Scientific literacy measurement data is analyzed descriptively using mean formulas that aim to explain the level of scientific literacy skills. Furthermore, a one-way ANOVA test was conducted to test differences in capabilities between the four groups based on the year batch. Data from interviews and document review were analyzed using content analysis techniques referring to Bengtsson (2016) which has the stages of decontextualization, recontextualization, categorization, and compilation.

## 3. RESULT AND DISCUSSION

The results of the study will be spelled out into three parts, first for the level of scientific literacy skills, second for contributing factors based on interviews, and finally confirmation of document analysis.

The results of the descriptive analysis use the mean formula and its forwards are categorized based on the criteria of Sudijono (2006). The mean and categorization results showed first-year students 42.39 (medium), second-year students 40.48 (medium), third-year students 44.86 (medium), and fourth-year students 53.38 (medium). The results of descriptive analysis can be viewed in the Table. 1.1.

Table 1.1 Results of Mean and Categorization of Scientific Literacy Level

| Score-interval | First-year student (N=28) | Second-year student (N=29) | Third-year student (N=22) | Fourth-year student (N=26) | Category |
|---|---|---|---|---|---|
| 81-100<br>61-80<br>41-60<br>21-40<br>0-20 | 42.39 | 40.48 | 44.86 | 53.38 | Very High<br>High<br>Medium<br>Low<br>Very Low |

The level of scientific literacy ability of pre-service biology teacher students from all years of generation is in the "medium" category. Anova test is carried out to find out whether there are significant differences between generations.

The results of the ANOVA analysis of the overall scientific literacy value show a significance value of 0.0002 <0.05, so it can be concluded that there is a significant difference between the scientific literacy abilities of student teacher candidates between batch years. Anova analysis results can be viewed in Table 1.2

Table. 1.2 Anova Analysis Results of The Overall Scientific Literacy Value

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Scientific Literacy Score | Between Groups | 2609.18 | 3 | 869.73 | 7.09 | 0.0002 |
| | Within Groups | 12380.67 | 101 | 122.58 | | |
| | Total | 14989.85 | 104 | | | |

The results of the LSD advanced test showed that fourth year students had a significant difference compared to first year students, second year students, and third year students. A summary of the results of the LSD further test can be viewed in Table 1.3

Table. 1.3 Summary of LSD Scientific Literacy Test

| Year | N | Mean | Std. Deviation | LSD Notation | |
|---|---|---|---|---|---|
| 1 | 28 | 42.39 | 13.30 | a | |
| 2 | 29 | 40.48 | 9.74 | a | |
| 3 | 22 | 44.86 | 11.01 | a | |
| 4 | 26 | 53.38 | 9.80 | | b |

Anova analysis is also carried out on each indicator, with the aim of finding out which indicators have significant differences. Anova test results per indicator show the following significance: Scientific argumentation (0.284> 0.05), Validation of literature (0.273> 0.05), Scientific information (0.387> 0.05), Experimental Design (0.001 <0.05), Making Graphics (0.061> 0.05), Data Interpretation (0.054> 0.05), Problem Solving (0.049 <0.05), Basic Statistics (0.004 <0.05), Inference (0.03> 0.05). Experiment Design Indicators, Problem Solving, Basic Statistics, and Inference have a significance of less than 0.05, so it can be concluded that these indicators are significantly different. The results of the ANOVA analysis and the results of the LSD advanced test analysis per indicator of scientific literacy can be seen in Table 1.4.

Table. 1.4 Anova Results and Summary of LSD Test for Scientific Literacy Indicators

| Indicator | Year | N | Mean | Std. Dev | Sig. | LSD Notation | | |
|---|---|---|---|---|---|---|---|---|
| Scientific argument | 1 | 28 | 29.61 | 21.02 | 0.284 | | | |
| | 2 | 29 | 34.34 | 24.46 | | | | |
| | 3 | 22 | 24.18 | 25.64 | | | | |
| | 4 | 26 | 37.12 | 27.33 | | | | |
| Literature validation | 1 | 28 | 40.43 | 26.38 | 0.273 | | | |
| | 2 | 29 | 47.21 | 24.64 | | | | |
| | 3 | 22 | 43.86 | 28.10 | | | | |
| | 4 | 26 | 53.81 | 23.47 | | | | |
| Scientific informa-tion | 1 | 28 | 25.00 | 44.10 | 0.387 | | | |
| | 2 | 29 | 31.03 | 47.08 | | | | |
| | 3 | 22 | 45.45 | 50.96 | | | | |
| | 4 | 26 | 42.31 | 50.38 | | | | |
| Experi-mental design | 2 | 28 | 41.31 | 20.08 | 0.001 | a | | |
| | 3 | 29 | 49.45 | 21.02 | | a | b | |
| | 1 | 22 | 53.25 | 18.95 | | | b | |
| | 4 | 26 | 64.62 | 21.66 | | | | c |
| Make a chart | 1 | 28 | 67.86 | 47.56 | 0.061 | | | |
| | 2 | 29 | 62.07 | 49.38 | | | | |
| | 3 | 22 | 63.64 | 49.24 | | | | |
| | 4 | 26 | 34.62 | 48.52 | | | | |
| Data interpreta-tion | 2 | 28 | 75.00 | 44.10 | 0.540 | | | |
| | 3 | 29 | 86.21 | 35.09 | | | | |
| | 1 | 22 | 72.73 | 45.58 | | | | |
| | 4 | 26 | 84.62 | 36.79 | | | | |
| Solution to problem | 1 | 28 | 41.96 | 25.51 | 0.049 | a | | |
| | 2 | 29 | 44.83 | 19.34 | | a | b | |
| | 3 | 22 | 57.95 | 22.34 | | | b | |
| | 4 | 26 | 54.81 | 26.48 | | | b | |
| Basic statistics | 1 | 28 | 41.96 | 25.79 | 0.004 | a | | |
| | 2 | 29 | 44.83 | 35.13 | | a | | |
| | 3 | 22 | 57.95 | 35.63 | | a | | |
| | 4 | 26 | 54.81 | 50.38 | | | b | |
| Inference | 1 | 28 | 20.07 | 18.80 | 0.030 | a | | |
| | 2 | 29 | 24.00 | 21.63 | | a | | |
| | 3 | 22 | 30.32 | 29.06 | | a | b | |
| | 4 | 26 | 37.00 | 17.37 | | | b | |

The results of the LSD advanced test on the Experimental Design indicator show that there is a significant difference between the experimental design abilities of fourth year students compared to first year students, second year students, and third year students.

The results of the LSD advanced test on the problem-solving indicator showed that there was a significant difference between fourth year students and third year students compared to first year students. Meanwhile, there is no significant difference in problem-solving abilities between second year students and first year students.

The results of the LSD advanced test on the basic statistics indicator show that there is a significant difference between the basic statistical abilities of fourth year students compared to first year students, second year students, and third year students.

The results of the LSD advanced test on the Inference indicator show that there is a significant difference between the inference ability of fourth year students compared to first- and second-year students, but not significantly different from third year students.

Although the scientific literacy of fourth year students is higher than first year students, second year students, and third year students, the grades of fourth year students are still in the "medium" category. Overall, it can be concluded that the level of scientific literacy of student teacher candidates is still not satisfactory, because as pre-service teachers are expected to have "good" scientific literacy, so that pre-service teachers are able to produce literate students (Maulidia et al, 2018).

The results obtained are similar to the research of Suwono & Furaida (2016) which shows that there is a significant difference between the scientific literacy of students who are more senior (third year students) and students who are more junior (first year students). The results of research by Shaffer et al (2019) show that there is a relationship between years of study and scientific literacy skills. Fourth year students have a longer learning experience so that it can affect their scientific literacy. This is supported by the opinion (Ekohariadi, 2009) which states that the learning experience is one of the factors that influence scientific literacy.

Exploration of student learning experiences from each batch year is carried out by interview. The focus of the question emphasizes the application of learning strategies, assignments, evaluations, and practicum. The results of the interviews from representatives will be explained as follows.

Students from all years of class argue that the majority of learning strategies applied by lecturers in theory courses still tend to use the lecture method, discussion, and presentation of study results. Only a small proportion of lecturers apply scientific literacy-based learning such as Problem Based Learning (PBL) and Project Based Learning (PjBL).

The implementation of learning strategies is aligned with the assignments that students receive. The majority of assignments received by students are compiling theoretical study papers, resumes, mind maps. Only a small part of research / project assignments.

First year students admit that they have not taken many biology courses and get PjBL learning only at the end of the Scientific Writing (KTI) course, as well as learning that relates to problems at several meetings of general biology courses. Second year students get PjBL learning only in certain subjects such as Plant Systematics and the Unity of Science Philosophy.

Third year students get PjBL in the courses of Natural Resource Conservation, Ecology, Plant Physiology, Bioentrepreneur, and several elective courses such as nutrition and toxicology. However, the implementation of PjBL and PBL was only limited to certain meetings. Meanwhile, fourth year students admitted to having received PjBL and PBL learning in several courses in previous semesters, but it was limited to only a few lecturers.

The experiences that students get when viewed from the strategies and assignments during lectures show that only a small proportion of subjects apply learning that can improve scientific literacy such as PjBL and PBL. Learning strategies are still dominated by theoretical learning, while learning that only focuses on memorizing concepts, theories and laws will cause students to have difficulty applying the knowledge they have gained in everyday life (Jufrida et al., 2019).

The results of the interview related to the evaluation given by the lecturer; each class answered that the majority of the evaluations only measured the knowledge of the concepts / theories / laws given during lectures. Evaluations that have scientific literacy content such as case study questions are only limited to certain subjects and only part of the items. For example, first year students get some case study questions in general biology courses, second year students in Plant Histology and Systematics subjects, third year students in Plant Physiology and Ecology courses, and fourth year students in Genetics, Biotechnology, Physiology, and Biochemistry courses.

Evaluation is an important part of a learning process because evaluation can be used as a starting point for the success of learning. Evaluation questions that only measure the level of knowledge, do not develop students' ability to solve a problem. According to Irwan (2020) the development of students' scientific literacy skills greatly depends on the types of questions given.

The application of scientific literacy-based learning is widely manifested in practicum courses. The results of interviews from all generations showed the same answer, namely that the majority of practicum implementation was carried out with structured inquiry. The practicum is carried out by means of the lecturer giving a problem and experimental procedures that are already available in the "recipe book". Students carry out the experiment as in the scenario, then report the results of the experiment in the form of a written report.

The application of structured inquiry at the student level actually does not have a significant effect on scientific literacy. Utami et al (2016) argue that in understanding the process and nature of science it is not enough to only ask students to carry out practicum activities using "recipe books".

The results of Adi et al (2017) 's research which compared structured inquiry and guided inquiry showed a significant difference. Guided inquiry is better able to improve student scientific literacy, because in guided inquiry students are asked to compile steps and compile experimental results independently, but still under the guidance of lecturers.

A number of other research results also confirm that guided inquiry is proven to increase scientific literacy (Ngertini, et al, 2013; Ristanto et al., 2017; Adi, et al, 2017; Arifin & Sunarti, 2017).

Review of Semester Learning Plans (RPS) and practicum instructions are carried out to confirm the results of student interviews. broadly speaking, the results of the RPS review and practicum instructions support the results of the interviews. In more detail, it will be explained as follows.

The RPS review begins by grouping the RPS into 2 categories, namely RPS for Theory Subject and RPS for Practical Subject. Learning strategies / methods, assignments, and evaluations are used as the basis for the RPS review.

The learning strategy applied to the majority theory course applies the lecture, question-and-answer, discussion, and presentation methods. Only a small proportion of RPS write strategies that refer to the development of scientific literacy such as discovery in general biology courses, PBL in natural resource conservation and toxicology courses, and PPA in bio-entrepreneurship, marine biology, and scientific writing (KTI) courses, but the application of strategies it is limited to a few meetings. Meanwhile, the RPS for the practicum course shows that the learning method applied is structured inquiry and a small part is there are projects / mini research in certain subjects and it is limited to the final meeting only.

The assignments applied by the lecturer are in line with the strategies applied so that the majority of assignments are in the form of papers, presentations, resumes, mind maps, and some assignments in the form of research article analysis. Assignments such as problem observation and research projects are rarely given by lecturers.

Evaluation / assessment of lecturers is also still dominated by exams that only test aspects of knowledge. Case study / problem solving questions are only rarely applied, and some are found in certain subjects such as nutrition, plant physiology, and ecology.

The results of the review of practicum instructions are very consistent with the results of interviews, namely the majority of practicum is carried out by applying structured inquiry. Problems, experimental steps, and tables of research results are available.

## 4. CONCLUSION

The level of scientific literacy skills of pre-service biology teacher students is in the "medium" category. There was a significant difference between the four groups of students with different years, the fourth-year students being the highest and significantly different. However, overall, it can be concluded that the level of pre-service student scientific literacy is still not satisfactory.

Student learning experience factors in terms of learning strategies, assignments, evaluations, and the type of practicum applied can contribute to the development of students' scientific literacy skills.

The implication in this study is that lecturers must identify students 'scientific literacy skills and carry out learning with learning strategies, assignments, evaluations, and practicum that support the growth of students' scientific literacy skills (for example: the application of Guided Inquiry, Project Based Learning, Project Based Learning, etc).

Students can be more independent in carrying out practicum or research projects so that they are expected to hone scientific literacy skills.

Faculties and departments as policy makers can also evaluate and focus curricula that emphasize the application of a learning process that supports scientific literacy.

## 5. REFRENCE

Adi, W. C., Suwono, H., & Suarsini, E. (2017). Pengaruh Guided Inquiry-Blended Learning terhadap Literasi Sains Mahasiswa Biologi. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, 2(10), 1369–1376.

Altun-Yalçn, S., Açşli, S., & Turgut, Ü. (2011). Determining the Levels of Pre-Service Science Teachers' Scientific Literacy and Investigating Effectuality of The Education Faculties About Developing Scientific Literacy.

*Procedia - Social and Behavioral Sciences*, 15, 783–787.

Arifin, L., & Sunarti, T. (2017). the Improvement of Students' Scientific Literay Through Guided Inquiry Learning Model on Fluid Dynamics Topic. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, 7(2), 68.

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. NursingPlus Open, 2, 8–14.

Cavas, P. H., Ozdem, Y., Cavas, B., Cakiroglu, J., & Ertepinar, H. (2013). Turkish Pre-service Elementary Science Teachers' Scientific Literacy Level and Attitudes Toward Science. *Science Education International*, 24(4), 383–401.

Dani, D. (2009). '*Scientific Literacy and Purposes for Teaching Science: A Case Study of Lebanese Private School Teachers',* 4(3), pp. 289–299.

De Moraes, J. V., & Castellar S. M. V. (2010). Scientific Literacy, Problem Based Learning and Citizenship: A Suggestion for Geography Studies Teaching. *Problems of Education in the 21st Century*, 19, 119–127.

Dragoş, V., & Mih, V. (2015). 'Scientific Literacy in School', *Procedia - Social and Behavioral Sciences*, 209 (July), pp. 167–172.

Ekohariadi. (2009). Faktor-faktor Yang Mempengaruhi Literasi Sains Siswa Indonesia Berusia 15 Tahun. *Jurnal Pendidikan Dasar*, 10(1), 29–43.

Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student's science literacy in the aspect of content science? *Jurnal Pendidikan IPA Indonesia*, 6(1), 81–87.

Gormally, C., Brickman, P., dan Lutz, M. 2012. Developing a Test of Scientific Literacy Skills (TOSLS): Measuring Undergraduates' Evaluation of Scientific Information and Arguments. *CBE—Life Sciences Education*, 11: 364-377.

Gormally, C., Brickman, P., Hallar, B., dan Armstrong, N. 2009. Effects of Inquiry-based Learning on Students' Science Literacy Skills and Confidence. *International Journal for the Scholarship of Teaching and Learning*, 3 (2): 1-22.

Gucluer, E., & Kesercioglu, T. (2012). The Effect of Using Activities Improving Scientific Literacy on Students' Achievement in Science and Technology Lesson. *Online Submission*, 1(1), 8–13.

Hernawati, D., Amin, M., Al Muhdhar, M. H. I., & Indriwati, S. E. (2019). Science Literacy Skills Through the Experience of Project Activities with Assisted Local Potential Based Learning Materials. *Jurnal Pendidikan Biologi Indonesia*, 5(1), 159–168.

Hidayah, N., Rusilowati, A., & Masturi, M. (2019). Analisis Profil Kemampuan Literasi Sains Siswa SMP/MTS Di Kabupaten Pati. Phenomenon*: Jurnal Pendidikan MIPA*, 9(1), 36.

Irwan, A. P. (2020). Analisis Kemampuan Literasi Sains Pesrta Didik Ditinjau Dari Kemampuan Menyelesaikan Soal Fisika Di Sman 2 Bulukumba. *Jurnal Sains Dan Pendidikan Fisika*, 15(3), 17–24.

Jufrida, J., Basuki, F. R., Kurniawan, W., Pangestu, M. D., & Fitaloka, O. (2019). Scientific literacy and science learning achievement at junior high school. *International Journal of Evaluation and Research in Education*, 8(4), 630–636.

Martin, M. O., & Mullis, I. V. S. (2015). *TIMSS 2015 International Results in Science*.

Maulidia, L., & Suwono, H. (2018). Persepsi Dosen Program Studi Pendidikan Biologi terhadap Integrasi dan Implementasi Komponen Literasi Saintifik dalam Desain Kurikulum. 2015, 1115–1121.

Ngertini, N.N., Sadia, I.W., & Yudana, I.M. Pengaruh Implementasi Model Pembelajaran Inkuiri Terbimbing terhadap kemampuan pemahaman konsep dan literasi sains siswa kelas x sma pgri 1 amlapura. e-Journal Program Pascasarjana Universitas Pendidikan Ganesha. 2013; 4(13): 1-8.

Novitasari, N. (2018). Profil Kemampuan Literasi Sains Mahasiswa Calon Guru Biologi. Biosfer: Jurnal Tadris Biologi, 9(1), 36.

OECD. (2019). *PISA 2018 Results. Combined Executive Summaries. Journal of Chemical Information and Modeling*, 53(9), 1689–1699.

Organization for Economic Co-Operation and Development. 2006. *Assessing Sscientific, reading, and mathematical literacy: A framework for PISA 2006*. Paris: OECD Publication.

Pratiwi1, S. N., Cari C., Aminah, N. S. 2019. Pembelajaran IPA Abad 21 dengan Literasi Sains Siswa. *Jurnal Materi dan Pembelajaran Fisika (JMPF)*, 9 (1), 34-42

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2017). Scientific literacy of students learned through guided inquiry. *International Journal of Research & Review*, 234(5), 23–30.

Saefi, M. (2017). *Pengaruh Blended-Challenge Based Learning terhadap Kemampuan Literasi Informasi, Berpikir Kritis, dan Literasi Sains pada Mahasiswa S1 Pendidikan Biologi Universitas Negeri Malang*. Tesis tidak diterbitkan. Universitas Negeri Malang, Malang

Shaffer, J. F., Ferguson, J., & Denaro, K. (2019). *Use of the test of scientific literacy skills reveals that fundamental literacy is an important contributor to scientific literacy*. CBE Life Sciences Education, 18(3).

Sudijono, A. (2006). *Pengantar Evaluasi Pendidikan*. Jakarta: Raja Grafindo Persada

Suwono, H., & Furaidah. (2016). the Scientific Literacy Level of First- and Third-Year Biology Student Teachers: A Comparative Study. *International Conference of Science Educators and Teachers (ISET) 2016, November*.

Suwono, H., Mahmudah, A. and Maulidiah, L. (2017) 'Scientific Literacy ofa Third Year Biology Student Teachers: Exploration Study', *KnE Social Sciences*, 1(3), p. 269.

Tias, I. W. U., & Octaviani, S. (2018). The Effect of Using the Project Based Learning Model On (Quasi Study Experiments for Class V Students of SD Negeri 8 Metro Timur, SD Negeri 1 Metro Barat, SD Negeri 1 Metro Utara dan SD Negeri 5 Metro Pusat). *Journal of Humanities and Social Studies*, 02(02), 25–30.

Utami, B., Saputro, S., Ashadi, & Masykuri, M. (2016). Scientific literacy in science lesson. *Prosiding ICTTE FKIP UNS 2015*, 1(1), 125–133.