23 (3), 2022, 1286-1295

Jurnal Pendidikan MIPA

e-ISSN: 2550-1313 | p-ISSN: 2087-9849

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

The Effect of Argumentation Skills and Problem Based Learning on Science Literacy of High School Students

Mawaddah Handayani* & Khairuna

Department of Biology Education, Universitas Islam Negeri Sumatera Utara, Indonesia

Abstract: Argumentation is one of the methods used to strengthen students' scientific concepts, especially in biology learning. This quantitative study aims to determine the effect of argumentation skills on students' scientific literacy and also to find out the improvement of students' scientific literacy by using argumentation skills of class X IPA-1 MAS CIPTA students of Simpang Dolok village. The population in this study involved the entire class X IPA-1 MAS CIPTA Simpang Dolok village, the sampling in this study used a simple random sampling technique without a control class. The instruments in this study were Essay test questions with scoring that adapted from TAP (Toulmin's Argumentation Petteren) for argumentation skills and essay tests for scientific literacy. The data was collected using a tabular sheet obtained from the argumentation Skill scores and the pretest and posttest scores for scientific literacy. As well as document documentation and photos. The data analysis technique uses the calculation of the N-gain score of scientific literacy due to the influence of Argumentation Skills, while the hypothesis testing uses a simple linear regression test and a paired simple t-test. The results of this study indicate that there is a positive and significant linear effect between argumentation skills on students' scientific literacy and a significant increase in students' scientific literacy using argumentation skills.

Keywords: scientific literacy, problem based learning, argumentation skill.

Abstrak: *Argumentasi merupakan salah satu cara yang digunakan untuk memantapkan konsep sains siswa terkhususnya pada pembelajaran biologi. Penelitian kuntitatif ini bertujuan untuk mengetahui pengaruh Skill argumentasi terhadap literasi sains siswa dan juga mengetahui peningkatan literasi sains siswa dengan menggunakan Skill argumentasi siswa kelas X IPA-1 MAS CIPTA desa Simpang Dolok. Populasi pada penelitian ini melibatkan seluruh kelas X IPA-1 MAS CIPTA desaa Simpang Dolok, pengambilan sample pada penelitian ini menggunakan teknik acak kelas (Simple Random sampling) tanpa kelas kontrol. Instrumen pada penelitian ini adalah soal tes Essay dengan penyekoran yang mengadaptasi dari TAP (Toulmin's Argumentation Petteren) untuk Skill argumentasi dan tes essay untuk literasi sains. Pengumpulan data dilakukan dengan menggunakan lembar berbentuk tabel yang diperoleh dari skor Skill argumentasi serta skor pretest dan posttest untuk literasi sains. Serta Dokumentasi dokumen dan foto. Teknik analisis data menggunakan perhitungan skor N-gain literasi sains akibat pengaruh Skill Argumentasi, sedangkan pengujian hipotesis menggunakan uji regresi linear sederhana dan uji paired simple t-tes. Hasil penelitian ini menunjukkan bahwa terdapat pengaruh linear yang positif dan signifikan antara Skill argumentasii terhadap literasi sains siswa dan terjadi peningkatan yang signifikan dari literasi sains siswa menggunakan Skill argumentasi.*

Kata kunci: *literasi sains, pembelajaran berbasis masalah, keterampilan argumentasi.*

Mawaddah Handayani
*Email: mawaddah.handayani@uinsu.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v23i3.pp1286-1295
Received: 14 September 2022
Accepted: 18 Oktober 2022
Published: 19 Oktober 2022

▪ INTRODUCTION

Education from time to time in various countries in the world is still a hot topic for debate (Harp et al., 1997). Especially in Indonesia, which is still a developing country, education is a complicated issue. However, as a nation that wants to move forward and has noble ideals listed in the 7 preambles of the constitution, namely the intellectual life of the nation. The Indonesian state certainly cannot stop its efforts in terms of developing and improving the quality of education. This is because education is the key to the success of a country. There are various indicators that indicate the success or failure of education in a country, one of which is literacy skills (Perkins, 1985).

Science learning is one of the important lessons that must be mastered by students. Sudarisman (2015) states that science has a major contribution to technological development. According to BSNP/Depdiknas in the journal Sudarisman (2015) stated that science learning is directed at creating an active atmosphere, crisis, analysis, in solving problems through the development of thinking skills. This thinking process includes observing, classifying, drawing conclusions, measuring, looking for relationships, conducting experiments, concluding and communicating (Wulandari, 2017). In the process of learning science, especially in biology learning, it is closely related to the ability to communicate, especially to argue. Argumentation can be said to be a communication that is made by everyone to defend themselves, to defend statements that they think are true and even to be able to influence others (Ekanara et al., 2018).

Argumentation is one of the methods used to strengthen students' science concepts, especially in biology learning. Students will learn to take steps in solving problems that become the topic of learning materials. There are several reasons that argumentation skills are very important to know, namely first, skills in argumentation can be used in determining learning actions so that they can improve understanding. Second, in science learning, especially argumentative biology, it must be developed in a balanced way in order to understand scientific ideas, and develop students' ability to collaborate (Devi et al., 2018).

Measurement of the level of scientific literacy of students is very important to determine the extent of students' literacy of the science concepts they have learned. Therefore, scientific literacy instruments are needed for students. Scientific literacy evaluation instruments already exist and can be adopted from PISA, but the results of Indonesian students' scientific literacy in international studies generally apply. Indispensable scientific literacy instrument for students of this type of test in a small scope. Because according to Sutrisna (2021) the results of the PISA study in 2018, show that the scientific literacy of Indonesian students is low based on OECD data, Indonesia is ranked 70 out of 78 participating countries with an average score of 396.

Scientific literacy may not have a consensus meaning (Ogunkola, 2013). However, the point of view of convergence is to help use scientific knowledge to solve practical problems in society (Hui et al., 2016). The problem with scientific literacy is due to the misinformation and misunderstanding of scientific information experienced by our society today. Scientific literacy is a broad construct that combines scientific opinions and concepts within and across different scientific disciplines and practices (Shwartz et al., 2006)

Based on Anelli (2011) scientific literacy is the extent to which science education helps people solve the everyday challenges faced by science. personally meaningful and make critical decisions related to science, able to overcome everyday challenges, sensitive to one environment, the hypothesis that globalization results when taking the right steps is scientific literacy. Based on Udompong & Wongwanich (2014) UNESCO is of the view that people who are scientifically literate can do much to reduce various challenges in society and also promote sustainable development. Educational reforms around the world in the past few decades have called for a scientifically literate society, especially in the US (Dani, 2009). According to Yordanka et al., (2010) critical thinking is one of the important components of scientific literacy which is an important repertoire to enable one to function as a responsible citizen in today's changing world. Science literate people must be able to utilize the skills, values and knowledge related to science for critical thinking, problem solving and decision making (Mayis & Genç, 2015). Glaze (2018) observes that scientific literacy can reduce the level of misconceptions in learning. Science literacy means understanding science and its applications, being able to think critically about science and dealing with scientific expertise. The development of a science-literate modern world is believed to be the focus of science education (Glaze, 2018). It is a common opinion that the development of scientific literacy is very important for science education (Gormally et al., 2012). Investigating students' scientific literacy skills improves the assessment of learning outcomes in science education (Segarra et al., 2018).

Maros & Juniar (2016) stated in their research that if students' literacy skills increase, students' argumentation skills will also increase. Students' argumentation skills can be raised in the learning process to improve students' scientific literacy skills. Students who have scientific literacy are students who are able to explain and predict natural phenomena and are able to identify scientific issues based on the science in them. A broader view of science is needed to solve the problems in it.

Basically, as we know that education will only succeed if it is supported by several factors, such as learning methods, discipline in learning and teaching, quality of teachers, learning books, and compiling materials based on the available curriculum, namely the 2013 curriculum (Dinatha & Laksana, 2007). 2017). The 2013 curriculum is a curriculum that prioritizes skills and character education and student understanding. The 2013 curriculum also develops science education, especially biology so that the world of education requires someone to have scientific literacy. Scientific principles that are used to solve problems or make decisions related to everyday life. Relevant learning can build students' awareness of the importance of science if it is linked to life in the present and in the future (Nofiana & Julianto, 2018).

After the initial observations were made in class X IPA-1 MAS CIPTA Simpang Dolok village there was a lack of scientific literacy in students during the learning process. Students are also not accustomed to being trained to take scientific literacy tests. This is because the learning process is still conventional and the students' lack of interest in reading in learning biology. As stated by Indonesian politician Fahri Hamzah (2020) through his discussion meeting with Akbar Faisal who stated that what resulted in low literacy was due to bad reading traditions. Based on information obtained through interviews with biology subject teachers, it is known that students' motivation to learn science, especially Biology, is not good. This also shows that students do not

yet have the characteristics of individuals who have scientific literacy. This problem is caused because students are not happy with the applied Biology learning so that there has not been an awareness in students that completing learning successfully is very important.

Efforts to develop students' scientific literacy can be done through a science learning process that provides opportunities for students to know science fully by not too much presenting science teaching as information (Kwan, 2009). However, with a process of justifying something based on reasons, estimates, evaluations, and considerations of different arguments. In this case, students' argumentation skills are raised during the learning process. The design of the learning process is to expose students to problem solving which is the topic of learning. Each student will observe and solve problems based on the student's personal point of view. The difference in the way of solving problems between one student and another will lead to an attitude to defend each other's arguments in various ways. Start by gathering evidence and facts. Students will also influence each other. The learning process designed as mentioned above can be done by applying Problem Based Learning (PBL). According to Sumarno et al., (2012) that "PBL is an instructional method that challenges students to learn to learn, work together in groups to find solutions to real problems". This problem is used to relate the curiosity and analytical ability of students and initiative to the subject matter. Prepare students to think critically and analytically and to find and use appropriate learning resources (Fakhriyah, 2014).

The purpose of this study was to determine the effect of argumentation skills on students' scientific literacy and also to determine the improvement of students' scientific literacy by using argumentation skills. The formulation of the problem from this research is whether there is an effect skills on students' scientific literacy? and is there an increase in students' scientific literacy by using argumentation skills?. This research needs to be done because of the challenges of globalization related to science issues, the development of science and technology which makes the education system develop so that it requires some student abilities, namely scientific literacy skills and argumentation skills. The results of this study are expected to provide alternative ways of learning to improve students' scientific literacy skills and provide an overview of students' scientific literacy achievements so that they can be used as references for teachers to develop learning by maximizing students' scientific literacy mastery and honing students' argumentation skills.

▪ METHOD

Research methods are generally a scientific way to generate data based on specific purposes and uses (Sugiyono, 2015). According to Suharsimi & Arikunto (2019) the research method is a research system in collecting data. The research method chosen was pre-experimental design. The pre-experimental design used was a one-group pretest-posttest design. starting with giving a pretest question to measure the subject's initial scientific literacy ability, then the subject is given treatment, namely the application of argumentation skills in Problem Based Learning learning model, then the subject is given a posttest question to measure literacy ability after being treated.

Participants

This research was conducted at the MAS CIPTA school in Simpang Dolok village with the entire population of class X-IPA MAS CIPTA in Simpang Dolok village. Sampling in this study used a simple random sampling technique, where participants were considered to have the same or homogeneous characteristics (Sugiyono, 2012). This technique is done with a small paper lottery. On the paper are written the names of three classes that correspond to the population in the school. During the draw, the IPA-1 class appeared which was designated as an experimental class (without a control class) with 37 students from the three existing classes.

Procedure

Before taking data, the instruments used in this study were validated first. This validation test is carried out to expert validators. After expert validation has been carried out and has received approval and is declared valid so that it is feasible for testing to be carried out on students. The instrument was tested on class X IPA-1 MAS CIPTA Simpang Dolok village with a total of 37 students. At the beginning of the biology learning meeting, the sample class was given a pretest to see the students' scientific literacy ability, then given treatment, namely the application of argumentation using Problem Based Learning (PBL) learning model. Assessment is carried out argumentation skill through an essay test given during the learning process. At the end of the lesson, students are given a final test (posttest) in the form of questions based on scientific literacy. The results of the pretest and posttest were calculated using the paired samples t test to determine the increase in students' scientific literacy and N-gain to analyze students' scientific literacy categories descriptively. Meanwhile, the posttest results and the observational results of argumentation skills were calculated using simple linear regression to determine the effect of argumentation skills on students' scientific literacy.

Instrument

In this study, the instrument used was argumentation skills using an instrument in the form of scoring which was used to assess students' arguments through essay tests given during the learning process. This student's argumentation skill scoring sheet was adapted from Toulmin's Argumentation Pattern (TAP). Meanwhile, scientific literacy uses an instrument in the form of essay questions which are used during the pretest and posttest.

Data Analysis

Technique analysis uses the calculation of the N-gain of scientific literacy due to the influence of argumentation skills, while the hypothesis testing uses a simple linear regression test and a paired simple t-test. Documentation in this study also includes data collection from various sources, such as documents and photos.

▪ RESULT AND DISSCUSSION

Before taking data, the instruments used in this study were validated first. This validation test is carried out to expert validators. After expert validation has been carried out and has received approval and is declared valid so that it is feasible for testing to be carried out on students. The instrument was tested on class X IPA-1 MAS CIPTA

Simpang Dolok village with a total of 37 students. Argumentation skills data were obtained by giving an essay test whose score determination was adapted from Toulmin's Argumentation Pettern (TAP) so that the test results obtained an average score. The average argumentation skill is 82.0 with the highest score of 90 and the lowest score of 80.

The scientific literacy variable data were obtained from the pretest and posttest scores. From the results of the pretest and posttest, N-gain to determine the extent to which students' scientific literacy increased descriptively. From the scientific literacy data that has been obtained by giving essay test questions consisting of 12 questions. The average N-gain 0.86. With the highest posttest score of 95 and the lowest score of 82. The graph of the N-gain data on students' scientific literacy due to the influence of argumentation skills can be seen in the following figure.

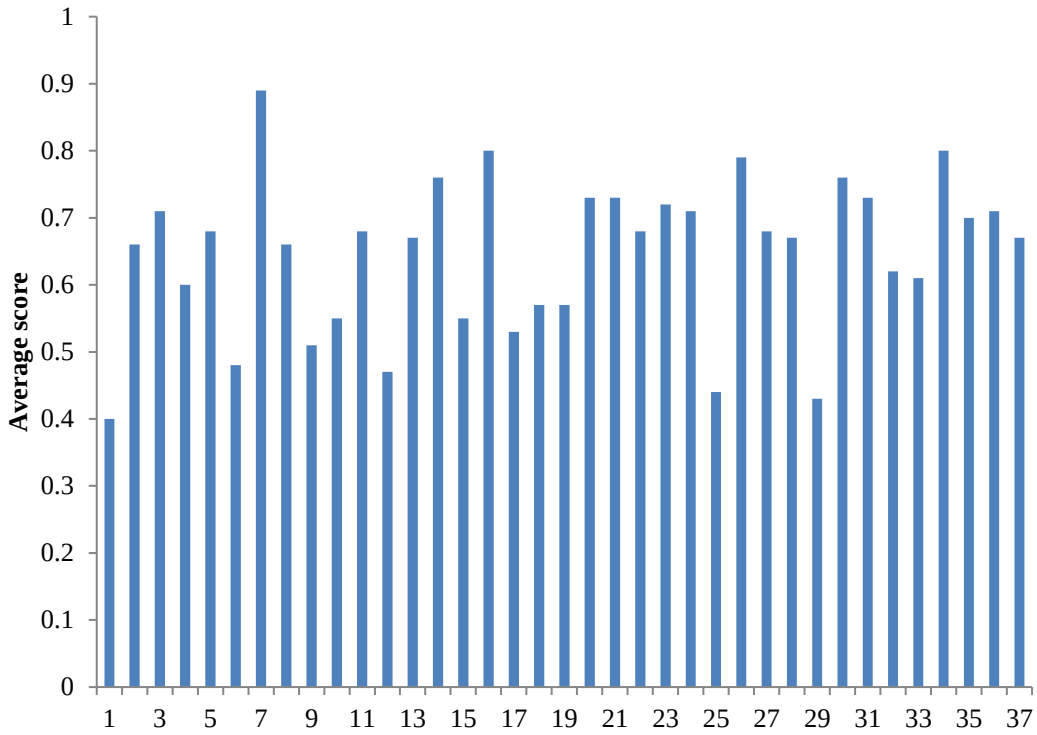

Figure 1. N-gain score of scientific literacy due to the effect of argumentation skills

The largest percentage for N-gain scientific literacy is in the range of 0.3 N-gain < 0.7 of 56.76%, which means that the increase in scientific literacy students due to the effect of argumentation skills Linearity test is also a prerequisite before performing regression to see whether the data that has been obtained is linear or not. Where two variables are said to have a linear relationship if the significance of (linearity) is less than 0.05. The results of the linearity test using the SPSS 22 program obtained the probability value or Sig. The results of the linearity test show that the value of sig. The linearity of argumentation skills and scientific literacy data is 0.000, because the significant value is less than 0.05, it can be concluded that argumentation skills there is a linear relationship between the variables of argumentation

First Hypothesis

The first hypothesis is to test whether there is an effect of argumentation skills on students' scientific literacy. The test using regression analysis shows that argumentation skills have a significant effect on the scientific literacy of class X IPA-1 MAS CIPTA Simpang Dolok village, in other words, students' scientific literacy is influenced by argumentation skills using the Problem Based Learning can be seen in the table 2.

Table 2. Linear regression analysis between argumentation skill and science literacy

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(constant)	11.739	9.463		1.241	0.223
Argumentation skills	0.907	0.1115	0.799	7.862	0.000

The result of regression coefficient test in table 2 are to find out in the regression model, the independent variable has a significant effect on the dependent variable. From the results of the analysis, it is found that the regression equation y = 11.739 + 0.907x, where if there is an increase of argumentation skills will increase the student's scientific literacy score of 38.133. So, there is an influence between argumentation skills in Problem Based Learning on students' scientific literacy. In addition, from the results of data analysis, it is also known that the r correlation value of the two variables is 0.799 with an r2 value of 0.628 indicating that the argumentation skills contribute to scientific literacy 80%, while the remaining 20% is caused by other variables that are not thorough.

Argumentation skills in the learning process are honed through the Problem Based Learning. Problem Based Learning supports students to argue, facing students with a given problem using the science concepts that have been studied. Students are stimulated to form their arguments through the problems given during the learning process. These results are in line with the findings of Abbas & Sawamura (2009) suggesting that a learning environment that supports students' arguments can improve students' ability to express their opinions and communicate their thoughts to form a structured reasoning line. In an effort to build the potential of argumentation skills in the learning process, Problem Based Learning is the right choice because the steps of the learning model can encourage or stimulate students to actively argue, especially when evaluating or reflecting. Ulpa et al., (2014) suggest that reflection activities in learning, such as presenting results in front of the class, can require students to master the assigned material. As it is also known that one of the characteristics of students who have scientific literacy is being able to understand concepts and master the material provided and be able to apply it in solving problems. It is clear that argumentation skills in learning need to be applied to form students who have good scientific literacy so that it can be said that argumentation skills affect students' scientific literacy.

Second Hypothesis

The second hypothesis is to test whether there is an increase in scientific literacy due to written argumentation skills using Problem Based Learning on students' scientific

literacy. Based on the paired sample t-test, it shows that there is an increase in students' scientific literacy due to argumentation skills in Problem Based Learning for students in tenth grade X IPA-1 MAS CIPTA Simpang Dolok village. From the results of the paired sample t-test, it shows that difference between before and after learning using argumentation skills is 1.710. It can be seen that the t-count is -16.33 and t-table is -2.990 means reject H0. This shows that there is a significant increase between the pretest and posttest of scientific literacy using argumentation skills. In addition, not all scientific competencies in scientific literacy can be achieved. As we know, that there are three scientific competencies in scientific literacy, identifying scientific issues, the ability to explain phenomena scientifically, and the ability to use scientific evidence.

In this study, among three scientific literacy competencies, most often applied by researchers is the student's competence in using scientific evidence for problem solving on argumentation skills. The use of scientific evidence in argumentation skills is to strengthen students' statements and opinions on the problems given through argumentation skills. Thus, if students have been able to use scientific evidence in order to strengthen their arguments, then this also means that students have achieved one of the scientific competencies in scientific literacy.

Based on this research, it can also be seen that there is an increase in students' scientific literacy, namely by the presence of individual characteristics who are scientifically literate in students, namely students have a positive attitude towards science. This can be seen through the seriousness and enthusiasm of students in learning during the research process. This is in line with Dinata et al., (2018) which suggests that the characteristics of individuals who have scientific literacy include having a positive attitude towards science and being able to use the scientific process. This also shows that there is an increase in students' scientific literacy due to the application of argumentation skills in the learning process.

▪ CONCLUSION

There is a positive and significant linear effect on argumentation skills in Problem Based Learning on the scientific literacy of class X IPA-1 MAS CIPTA in Simpang Dolok village and a significant increase of students' scientific literacy due to argumentation skills. Science literacy skills will develop well if educators can master materials and methods in Biology learning well. The scientific literacy is very important to be developed as a provisions for students in face high competitiveness in massive development of information technology and global competition.

▪ REFERENCES

Abbas, S., & Sawamura, H. (2009). Developing an argument learning environment using agent-based ITS (ALES). EDM’09 - Educational Data Mining 2009: 2nd International Conference on Educational Data Mining, 200–209.

Anelli, C. (2011). Scientific literacy: what is it, are we teaching it,and does it matter American Entomologist, 57(4), 235–244.

Dani, D. (2009). Scientific literacy and purposes for teaching science: A case study of lebanese private school teachers. International Journal of Environmental and Science Education, 4(3), 289–299.

Devi, N. D. C., Susanti VH, E., & Indriyanti, N. Y. (2018). Analysis of high school students' argumentation ability in the topic of buffer solution. JKPK (Jurnal Kimia Dan Pendidikan Kimia), 3(3), 14-26.

Dinata, A. N., Adisendjaja, Y. H., & Amprasto, A. (2018). Pengaruh field trip terhadap kemampuan literasi sains dan sikap terhadap sains siswa SMA pada materi ekosistem [The effect of field trip on science literacy ability and attitude towards science of high school students on ecosystem materials]. Assimilation: Indonesian Journal of Biology Education, 1(1), 8–13.

Dinatha, N. M., & Laksana, D. N. L. (2017). Kesulitan belajar siswa dalam mata pelajaran IPA terpadu [Studens' learning difficulties in integrated science subject], Archipelago Basic Education. 1(2), 214–223.

Ekanara, B., Adisendjaja, Y. H., & Hamdiyati, Y. (2018). Hubungan kemampuan penalaran dengan keterampilan argumentasi siswa pada konsep sistem pencernaan melalui pembelajaran Problem Based Learning [The reliationship between reasoning abiliti and studens' argumentation skills on the concept of the digestive system through Problem Based Learning], Biodidactica, Journal of Biology and Its Learning. 13(2). 36-77

Fakhriyah, F. (2014). Penerapan Problem Based Learning dalam upaya mengembangkan kemampuan berpikir kritis mahasiswa [Application of Problem Based Learning in an effort to develop studens' critical thinking skills]. Indonesian Science Education Journal, 3(1), 95–101.

Glaze, A. L. (2018). Teaching and learning science in the 21st century: Challenging critical assumptions in post-secondary science. Education Sciences, 8(1), 1–8.

Gormally, C., Brickman, P., & Lut, M. (2012). Developing a test of scientific literacy skills (TOSLS): Measuring undergraduates' evaluation of scientific information and arguments. CBE Life Sciences Education, 11(4), 364–377.

Harp, F. & Mayer, R. E. (1997). The role of interest in learning from sientific text and ilustrations: On the distintion between emotional interest in conitive interest. Journal of Education Psyhology, 81(2), 240–246.

Hui, F,. & Komplin, M. (2016). The implementation of authetic activities for learning: A case study in finance education. E-Journal Of Bussines Education & Scholarship Of Thiching, 5(1), 59–72.

Kwan, A. (2009). Problem-based learning. The Routledge interntional handbook of higher education, 91-109.

Maros, H., & Juniar, S. (2016). Penerapan pembelajaran kontekstual untuk meningkatkan literasi sains dan kualitas argumentasi siswa pondok pesantren Daarul Uluum Pui Majalengka pada diskusi sosiosaintifik IPA [Application of contextual learning to improve scientific literacy and argumentation quality of Daarul Uluum Pui Majalengka Islamic Boarding School students in science socio-scientific discussions], Tarbiyah Journal. 21(1), 1–23.

Mayis, O., & Genç, M. (2015). Ondokuz mayıs universitesi eğitim fakültesi dergisi the effect of scientific studies on students' scientific literacy and attitude. Fak. Derg. / OMU J. Fac. Educ, 34(1), 141–152.

Nofiana, M., & Julianto, T. (2018). Upaya peningkatan literasi sains siswa melalui pembelajaran berbasis keunggulan lokal [Efforts to improve students' scientific

literacy through local excellence-based learning] Biosphere: Tadris Biology Journal, 9(1), 24.

Ogunkola, B. J. (2013). Scientifict literacy: Conceptual overview, importance, and strategis for improvement. Journal of Education and Social Research, 3(1), 265–274.

Perkins, D. N. (1985). Postprimary education has little impact on informal reasioning. Journal Of Research in Science Teaching, 41(10), 994–1020.

Segarra, V. A., Hughes, N. M., Ackerman, K. M., Grider, M. H., Lyda, T., & Vigueira, P. A. (2018). Student performance on the test of scientific literacy skills (TOSLS) does not change with assignment of a low-stakes grade. BMC Research Notes, 11(1), 1–5.

Shwartz, Y., Ben-Zvi, R., & Hofstein, A. (2006). The us of sientific literacy taxonomy for asessing the develoment of chemical literacy among high-school student. Chemistry Education Research and Practice, 7(4), 203–225.

Sudarisman, S. (2015). Memahami hakikat dan karakteristik pembelajaran biologi dalam upaya menjawab tantangan abad 21 serta optimalisasi implementasi kurikulum [Understanding the nature and characteristics of learning biology in an effort to answer the challenges of the 21st century and optimizing curriculum 2013 implementation]. Florea: Journal of Biology and Its Learning, 2(1), 29–35.

Sugiyono. (2012). Quantitative, Qualitative, and R&D Research Methods. Bandung: Alphabeta.

Sugiyono. (2015). Quantitative Research Methods and R&D (Cet.21). Bandung: Alphabeta.

Suharsimi A. (2019). Research Procedure A Practical Approach. Jakarta: Rineka Cipta.

Sumarno, U., Hidayat, W., Zukarnaen, R., Hamidah, & Sariningsih, R. (2012). Kemampuan dan disposisi berpikir logis, kritis, dan kreatif matematik [Ability and disposition to think logically, critically, and creatively in mathematics]. MIPA Teaching Journal, 10–27.

Sutrisna, N. (2021). Analisis kemampuan literasi sains peserta didik SMA di kota Sungai Penuh [Analysis of the scientific literacy skills of high school students in the city of Sungai Penuh]. Journal of Research Innovation, (12), 2683.

Udompong, L., & Wongwanich, S. (2014). Diagnosis of the scientific literacy characteristics of primary students. Procedia - Social and Behavioral Sciences, 116, 5091–5096.

Ulpa, M., Abdurrahman, & Wahyudi, I. (2014). Perbandingan hasil belajar fisika ditinjau dari kemampuan argumentasi oral dan tertulis [Comparison of physics learning outcomes in terms of oral and written argumentation skills]. Journal of Learning Physics, University of Lampung, 2(3), 1–13.

Wulandari, R. (2017). Berpikir ilmiah siswa dalam pembelajaran IPA untuk meningkatkan literasi sains [Students' scientific thinking in science learning to improve scientific literacy]. SEJ (Science Education Journal), 1(1), 29–35.

Yordan-ka, S., Minevska, M., & Evtimova, S. (2010). Scientific literacy : Problems of science education in bulgarian school. Problems of Education in the 21st Century, PROBLEMS O(mic), 113–118.