JPPIPA 9(10) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

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

The Relationship between Misconceptions and Students' Scientific Literacy Abilities on Global Warming Material

Eva Aini[1*], Evendi[1], A. Halim[1], M. Syukri[1], Yusrizal[1]

[1] Syiah Kuala University, Banda Aceh, Indonesia.

Received: July 20, 2023
Revised: August 31, 2023
Accepted: October 25, 2023
Published: October 31, 2023

Corresponding Author:
Eva Aini
ainieva54@gmail.com

DOI: 10.29303/jppipa.v9i10.5156

Abstract: This study aims to identify misconceptions experienced by students, the level of scientific literacy skills and the relationship between misconceptions and scientific literacy skills on global warming. The research method used is correlational research with a quantitative approach. The sample selected was 80 students using purposive sampling technique. The instrument used was 10 items to measure misconceptions with a four-tier multiple choice diagnostic test and 10 test items to measure scientific literacy skills. The results of the analysis of misconceptions with CRI showed that the category of misconceptions was 44% with moderate criteria, students who understood the concept were 32% and did not understand the concept by 32%. The results of the analysis of scientific literacy skills obtained an average value of 40.65, a percentage of 40.7% and is in the low category after interpretation. The aspect of scientific literacy that is measured in the highest percentage is the context aspect with an average percentage of 48.1%, the knowledge aspect is 40.4% and the competence aspect is 34.1%. The results of the analysis of the relationship between misconceptions and scientific literacy skills were carried out using the Pearson product moment correlation test which showed a positive and significant relationship with a significant value of 0.008 < 0.05 and a large correlation value of 0.270 with a low category. Based on the hypothesis test, the results show that there is a positive relationship between misconceptions and scientific literacy skills with t_{count} 2.476 > t_{table} 1.990.

Keywords: Misconceptions; Relationship; Science literacy ability

Introduction

One of the learning difficulties experienced by students is the lack of mastery of concepts which causes students to experience misunderstandings. Misconceptions in accepting inappropriate concepts are called misconceptions (Nurulwati et al., 2014). Misconception is defined as a state where ideas, ideas or thoughts are not in accordance with scientific concepts (Türkoguz, 2020). Misconceptions in science are interpreted as students' ideas that are not well structured and produce wrong meanings and are not in accordance with scientific concepts (Soeharto et al., 2019). Misconceptions that occur in students can be stored in their cognitive structure for a long time so that they affect the construct of further knowledge (Rokhim et al., 2023). So that misconceptions will affect students' abilities and have an impact on learning outcomes (Nurulwati & Rahmadani, 2019).

In science learning, misconceptions can occur when students try to understand abstract concepts (Rokhim et al., 2023). One of the physics materials that has abstract concepts and most students find it difficult is global warming material. This material describes processes and events that occur in nature that cannot be directly observed, what causes global warming and what are the impacts on ecosystems (Setianita & Liliawati, 2019). Global warming is one of the materials that is very important to understand considering that the phenomenon of global warming is a global environmental problem (Darwis & Hardiansyah, 2022). This unresolved misconception causes learning difficulties for students. These misconceptions can be reduced by testing students' prior knowledge to identify early on the misconceptions experienced by students

How to Cite:
Aini, E., Evendi, E., Halim, A., Syukri, M., & Yusrizal, Y. (2023). The Relationship between Misconceptions and Students' Scientific Literacy Abilities on Global Warming Material. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 8051–8058. https://doi.org/10.29303/jppipa.v9i10.5156

(Widarti et al., 2021). So it is necessary to describe the quantity of misconceptions experienced by students so that misconceptions can be prevented and improvements in future learning (Ritonga et al., 2018).

Misconceptions can be analyzed using instruments that can reveal the location of misconceptions and their causes in depth. There are various instruments for diagnosing the existence of misconceptions, one of which is a four-tier diagnostic test. The four-tier multiple choice diagnostic test consists of answers to multiple choice questions (tier 1), the confidence level for the answers to the first tier (tier 2), the reasons for the answers to tier 1 (tier 3), and the confidence level for the reasons (tier 4) (Jusniar et al., 2020). The four-tier multiple choice diagnostic test in this study was accompanied by the Certainty ogf Response Index (CRI) analysis method. CRI is a method for measuring the level of confidence or certainty of respondents in answering each question (Qodriyah et al., 2020; Rokhim et al., 2023). CRI is a measure of the level of confidence or certainty of a response in answering each question given using a fixed scale (Yuberti et al., 2020).

Low science learning can be indicated by the low ability of students' scientific literacy (Rusilowati et al., 2016). Low mastery of concepts is one of the obstacles in the learning process which results in low learning outcomes. One of the causes of students' low understanding of concepts is the existence of misconceptions and learning conditions that do not pay attention to the initial concepts (preconceptions) that students have (Fitria, 2014). The results of Nofiana et al. (2017) found that students' mastery of science concepts was still low, the tendency of teachers to provide material without relating it to real life caused students difficulties in understanding and applying it. Misconceptions are one of the causes of students' low scientific literacy (Fuadi et al., 2020).

Students' weak scientific literacy abilities have been proven by the results of scientific literacy assessments at the international level. The Program for International Students Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) are programs created and developed by the Organization for Economic Co-operation and Development (OECD) to describe the literacy quality of a country. Based on the 2018 PISA data, as many as 70% of Indonesian students have not been able to solve level 2 questions and only level 1 can be completed, seen from the PISA research framework (OECD, 2019a). Research has been extensive and it has been found that students' misconceptions are closely related to science learning and influence students' academic achievement in science subjects (Laliyo et al., 2020; Park & Liu, 2021; Wernecke et al., 2018). Students who experience difficulties in understanding related concepts will lead to low science learning achievement, as evidenced by the lowest scientific achievement of Indonesian students out of 41 countries in the results of the 2018 PISA study (OECD, 2019a).

Scientific literacy is the ability of someone who can describe, provide explanations and predict natural phenomena (DeBoer, 2000). According to OECD (2019b) scientific literacy consists of three interrelated aspects, namely knowledge, context and competence. The context is personal, local/national, global issues that are currently occurring and require the concept of science and technology. Knowledge of context aspects is needed to explain that a student has scientific capabilities. Aspects of competence are capabilities in explaining scientifically occurring events, providing evaluations, and drafting scientific investigations as well as making interpretations of data and facts. In order for students to achieve competency, students must have knowledge and understanding of science. Scientific literacy abilities can be measured using several questions from PISA (Zulanwari et al., 2023).

According to Adawiyah (2017), scientific literacy abilities can be measured using scientific literacy-based test instruments. According to Rahim et al. (2016) making a good scientific literacy assessment measuring tool must refers to competence base and competence scientific PISA which is adapted to the PISA characteristic questions. Scientific literacy questions have a characteristic, which is that they always begin with an introductory text containing a context familiar to students, which is then followed by questions related to the content. The tests used can be multiple choice questions or essays.

Previous research has researched a lot regarding the relationship, interrelationship, influence between misconceptions and students' academic abilities such as learning outcomes, critical thinking abilities, cognitive conflict, self-efficacy, and so on. Research conducted by Hidayatullah et al. (2020) found that students who were not able to experience the four thinking processes thus still had misconceptions, students with high, medium and low abilities still had misconceptions when learning parabolic motion material. However, there has been no research to measure the level of relationship or link between misconceptions and scientific literacy abilities in physics material. Based on initial observations and interviews at SMA Negeri 1 Peusangan as a research school, it was found that misconceptions still occur among students regarding physics material, students' scientific literacy abilities also show poor results, this can be seen in the results of the minimum competency assessment exam (AKM) which tested by a teacher in the field of physics studies. The problem that occurs is that

teachers assume that students have misconceptions and low scientific literacy abilities by looking at learning outcomes through school exams, but teachers have never identified misconceptions and scientific literacy abilities more specifically. Based on several of these problems, the researcher wants to study further in analyzing students' misconceptions related to scientific literacy abilities where there is no information related to global warming material.

This research has several objectives, namely to identify students' misconceptions, determine the level of students' scientific literacy abilities, and determine the relationship between misconceptions and students' scientific literacy abilities on global warming material. The hypothesis or provisional assumption in this research is that there is a connection between misconceptions and students' scientific literacy abilities in global warming material.

Method

This study uses a quantitative approach to the type of correlational research. This research was carried out at SMA Negeri 1 Peusangan with a research sample of 80 class XI IPAS students using a purposive sampling technique with an error rate of 5%. The instruments used in this study were 10 items on a four-tier multiple choice diagnostic test accompanied by CRI to measure the level of misconceptions experienced by students, 10 items on a scientific literacy test to measure students' scientific literacy skills and an interview guide as an initial observation. Both of these question instruments have been tested for feasibility by experts and respondents, so they are valid and feasible to use in research.

The results of the four-tier multiple choice diagnostic test are grouped based on the combination of students' answers with the CRI scale and the criteria to find out students can distinguish what they understand and what they do not understand. Data on the results of diagnostic tests and scientific literacy tests were analyzed using descriptive statistics from the scores obtained and interpreted. The relationship between misconceptions and students' scientific literacy abilities was analyzed using the Pearson product moment correlation test assisted by SPSS 24.0 for Windows to obtain correlation coefficient values and interpreted in five categories. The correlation coefficient was then tested for significance using the SPSS 24.0 for windows assisted t test to determine the hypothesis.

Results and Discussion

Student Misconceptions on Global Warming Material

Based on the four-tier multiple-choice diagnostic test, results were obtained that described the level of students' understanding of concepts in three categories, that is understanding concepts, misconceptions and not understanding concepts. In general, the level of students' understanding of the concept of global warming can be seen in Figure 1.

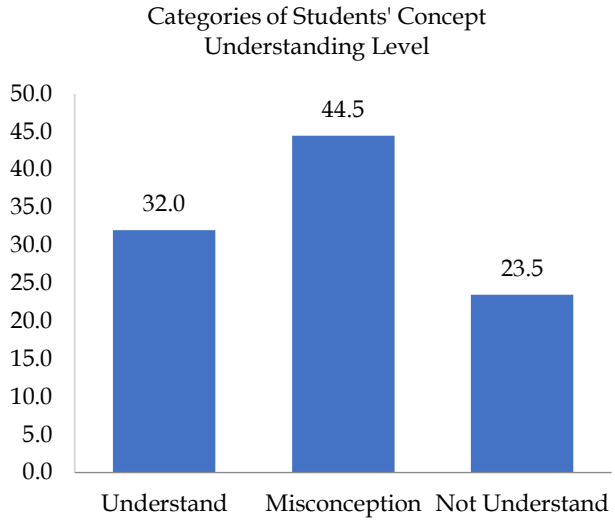

Figure 1. Comparison of the percentage of students' understanding of the concept

Based on Figure 1 above, it shows that students still experience misconceptions in the medium category with a percentage of 44.5%. Misconceptions are at the highest percentage compared to other categories. The concept understanding category has a percentage of 24% and the percentage of students who do not understand the concept is 32%. This shows that almost half of the students in the research sample still experience conceptual misunderstandings in the global warming material and on average students who answer incorrectly have higher confidence than students who answer correctly. Furthermore, the percentage of misconceptions that occur in each question indicator can be seen in Table 1.

Based on table 1, it shows that the highest percentage of misconceptions experienced by students is in the indicator questions related to determining the causes of global warming and analyzing the relationship between temperature changes and greenhouse gas emissions in global warming, where the percentages of the two indicators are above 50%, namely 62.5% and 60.0%. Other indicators are below 50%, the question indicators in question are determining the occurrence of the greenhouse effect through the symptoms that occur by 43.8%, selecting correct statements regarding the

ozone layer by 48.1%, analyzing scientific data related to the effect of temperature on global warming by 37.5%, calculating greenhouse gas emissions as the cause of global warming by 31.3%, analyzing the impact of global warming on the environment and human life by 40.0%, proposing ideas for solutions to global warming by 35.0% and explaining international agreements by 38.8%. So it can be concluded that the highest percentage of misconceptions is in the indicator analyzing the relationship between temperature changes and house gas emissions in global warming, while the lowest percentage of misconceptions is in the indicator calculating greenhouse gas emissions as the cause of global warming.

Table 1. Summary of Percentage of Misconceptions on Indicators

Indicator	Question item	Misconceptions (%)
Determining the greenhouse effect events through the symptoms that occur	1	43.8
Select the correct statements regarding the ozone layer	2, 4	48.1
Determine the causes of global warming	6	60.0
Analyzing scientific data regarding the effect of temperature on global warming	7	37.5
Calculating greenhouse gas emissions as a cause of global warming	9	31.3
Analyze the impact of global warming on the environment and human life	3	40.0
Proposing ideas regarding solutions to global warming	8	35.0
Explain international agreements	5	38.8

The type of misconception experienced by students regarding global warming material with the highest percentage is based on the graph between the amount of CO_2 and global temperature simultaneously decreasing, the cause of global temperature increasing is due to the increasing amount of carbon dioxide. This misconception is at a percentage above 10%, namely 62.5%. The correct concept is that in both graphs in the matter of finding the amount of CO_2 and global temperature both have increased, the earth's global temperature has increased due to the increasing amount of carbon dioxide emissions that have gathered in the atmosphere, this greenhouse gas emitted by the earth cannot be passed on to the atmosphere and even reflected back to earth (Muchyar et al., 2015).

Students' Scientific Literacy Ability on Global Warming Material

Based on the calculation of students' scientific literacy tests using descriptive statistics, the results showed that students' scientific literacy skills were at a percentage of 40.7% and belonged to the low category. The distribution of the results of calculating students' scientific literacy abilities is shown at Table 2.

Table 2. Descriptive Statistics of Students' Scientific Literacy

Classification	Score Intervals	Frequency	Percentage (%)
Very high	80 – 100	0	0
High	66 – 79	1	1.25
Currently	56 – 65	12	15
Low	40 – 55	31	38.75
Very low	≤39	36	45
Amount		80	100
Average Percentage			40.7

Table 2 shows the percentage of 0% in the very high classification so that there are no students who have very high ability, 1.25% of students have high ability, 15% of students have moderate or sufficient ability, 38.75% of students have low ability, and 45% of students have very low abilities. The highest percentage of students' scientific literacy ability test results is in the very low category, namely 45%, while the lowest percentage is 0% or no students have very high scientific literacy abilities. So overall the average percentage for students' scientific literacy skills in global warming material is relatively low with an average percentage of 40.65%. This means that students have not prepared themselves to take part in science learning which involves problem solving processes and the interaction of science with technological developments (Rohman et al., 2017).

A low percentage of research was also found by Zulanwari et al. (2023) in class X students at SMA Negeri 1 Sakra based on PISA questions at 46.62%. In line with research by Zulanwari et al. (2023) which stated that the low results of students' scientific literacy abilities in solving PISA level questions were caused by students' lack of ability to pay close attention to questions, understand reading content, and high reasoning abilities. The low level of scientific literacy is also caused by students' lack of interest in reading (Susiati et al., 2018). Furthermore, the percentage of each aspect of scientific literacy consisting of context, knowledge and competency aspects can be seen in Table 3.

Table 3. Recapitulation of Aspects of Scientific Literacy

Aspect	Percentage (%)	Category
Context	48.1	Low
Knowledge	40.4	Low
Competence	34.1	Very low
Average	40.7	Low

Based on table 3, it can be seen that the average achievement of scientific literacy skills in the context, knowledge and competency aspects as a whole is 40.7 % with a low achievement category. The lowest scientific literacy aspect is the competency aspect of 34.1%, while the highest aspect is the context aspect with a percentage of 48.1%. This shows that students are more capable of answering contextual aspects of questions than other aspects, which means students can relate material concepts to everyday life.

The Relationship between Misconceptions and Students' Scientific Literacy Abilities

Misconceptions and students' scientific literacy skills were tested for their relevance using the Pearson product moment correlation test. The data used are the results of a four-tier multiple choice diagnostic test and a scientific literacy test. The data obtained were tested for normality, homogeneity and linearity using SPSS 24.0 for windows as a prerequisite for analysis before conducting a correlation test. Based on SPSS 24.0 calculations for windows, the results obtained for both data are normally distributed with sig. 0.200 > 0.05 (significant level) on the Kolmogorov-Smirnov test, both data are also homogeneous with a sig. 0.430 > 0.05 (significant level) in the homogeneity test, and both data have a linear relationship with the sig value 0.021 < 0.05 in the linearity test. After getting the results of the prerequisite analysis test, the Pearson product moment correlation test can be carried out.

Pearson product moment correlation test in this study is a test that aims to find correlations or links between misconceptions as variable X and scientific literacy skills as variable Y. The correlation test in this study was carried out using SPSS 24.0 for windows, and the SPSS test results obtained were seen in Table 4.

Table 4. Pearson Product Moment Correlation Test Results

Variable	N	Average	Standard Deviation	Correlation coefficient	Sig.	r^2
Misconceptions (X)	80	30.38	15.381	0.270	0.008	0.073
Science Literacy Ability (Y)	80	40.29	13.725		0.008	

Based on Table 4 above, the value of the correlation coefficient (r) between misconceptions and scientific literacy skills is 0.270 with a low level of relationship. The correlation coefficient value of 0.270 is close to 0 so that the relationship between misconceptions and scientific literacy is a weak relationship because it is in the low category. The direction of the relationship between the variables in this study is based on the positive r value, so that the relationship between these two variables, namely students' misconceptions and scientific literacy skills, is unidirectional. This unidirectional nature means that an increase in scientific literacy skills is followed by an increase in misconceptions, but on a low scale. The relationship between misconceptions and scientific literacy abilities is a significant relationship. Based on the results obtained, the significance value obtained was 0.008 which is less than 0.05, it means that there is a significant relationship between misconceptions and students' scientific literacy abilities.

The magnitude of the contribution between misconceptions and scientific literacy skills can be seen based on the analysis of the coefficient of determination which shows the value of $r^2 = 0.073$. The value of r^2 is then converted into a percentage by multiplying the determinant coefficient of r^2 x 100% so that a contribution of 7.3% is obtained. The results of the correlation test showed a significant difference, this means that the variance that occurs in the scientific literacy ability variable, 7.3% is determined by the variable that occurs in misconceptions or it can be said that scientific literacy ability is influenced by misconceptions of 7.3% and the remaining 92.7% is determined by other factors.

To test the hypothesis of this study using the t test with the help of SPSS 24.0 for windows, the results obtained are t_{count} 2.476 > t_{table} 1.990 at a significant level of 0.5. According to the criteria, if $t_{count} > t_{table}$, then H_0 is rejected and H_a is accepted, meaning that there is a positive relationship between misconceptions and scientific literacy abilities. This means that an increase in students' scientific literacy skills is followed by an increase in misconceptions, but in the low category. So that students who have scientific literacy skills can still experience misconceptions, in other words scientific literacy skills are followed by misconceptions experienced by students. Misconceptions can be the cause of students' high and low scientific literacy abilities. Misconceptions affect students' scientific literacy abilities. As previous researchers Darwis & Hardiansyah (2022) argued that the fact of the low achievement of students in science learning based on PISA is one of the characteristics or effects of misconceptions. Pujayanto & Haryani (2022) also found that students' natural science abilities were still very low due to a low level of understanding and misconceptions. Based on the results of this study, it also proved the results of interviews, where the teacher gave an overview of students still experiencing misconceptions and low scientific literacy skills on global warming material at SMA Negeri 1 Peusangan.

Conclusion

Based on the research that has been done, it can be concluded that class XI students at SMA Negeri 1 Peusangan still experience misconceptions of 44.5 % in the moderate category. Students experience the highest misconceptions on indicators analyzing the relationship between temperature changes and greenhouse gas emissions in global warming. The ability of students' scientific literacy is still relatively low with an achievement percentage of 40.7%, the highest aspect of scientific literacy mastered by students is the aspect of context. Based on the results of data analysis on misconceptions and scientific literacy skills, it shows that there is a positive and significant correlation with a correlation coefficient of 0.270 and is in the low category or the relationship is not very strong. This means that students who have high or low scientific literacy skills can still experience misconceptions.

Acknowledgments
Thank you to the entire supervisor team for their guidance and assistance during this research, as well as constructive and useful advice so that this research could be completed.

Author Contributions
Eva Aini, Evendi, and A. Halim conceptualized the research idea, designed of methodology, management and coordination responsibility, analyzed data, conducted a research and investigation process; M. Syukri and Yusrizal conducted literature review and provided critical feedback on the manuscript.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflicts of interest.

References

Adawiyah, R. A. (2017). *Pengembangan Instrumen Tes Berbasis Literasi Sains dalam Aspek Menjelaskan Fenomena Ilmiah Materi Pokok Energi* (Doctoral Dissertation). UIN Sunan Kalijaga. https://doi.org/10.29303/jipp.v5i2.122

Darwis, R., & Hardiansyah, M. R. (2022). Analisis Miskonsepsi Calon Guru IPA Terpadu pada Materi Pamanasan Global Menggunakan Certainty of Response Index. *Jurnal Pendidikan MIPA*, *12*(4), 1023-1030. https://doi.org/10.37630/jpm.v12i4.732

DeBoer, G. E. (2000). Scientific Literacy: Another Look at Its Historical and Contemporary Meanings and Its Relationship to Science Education Reform. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *37*(6), 582-601. https://doi.org/10.1002/1098-2736

Fitria, A. (2014). *Miskonsepsi Mahasiswa dalam Menentukan Grup pada Struktur Aljabar Menggunakan Certainty of Response Index (CRI) di Jurusan Pendidikan Matematika IAIN Antasari* (Doctoral Dissertation). Universitas Islam Negeri Antasari. Retrieved from https://core.ac.uk/download/pdf/327227535.pdf

Fuadi, H., Robbia, A. Z., Jamaluddin, J., & Jufri, A. W. (2020). Analisis Faktor Penyebab Rendahnya Kemampuan Literasi Sains Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan*, *5*(2), 108-116. https://doi.org/10.29303/jipp.v5i2.122

Hidayatullah, Z., Jumadi, J., Nadhiroh, N., Kartika, E., Nuha, A. A., & Erlangga, S. Y. (2020). Identifikasi Miskonsepsi dan Konflik Kognitif Fisika: Kasus Terkait Perubahan Konseptual. *Edusains*, *12*(1), 64-71. Retrieved from https://core.ac.uk/download/pdf/348690976.pdf

Jusniar, J., Effendy, E., Endang, B., & Sutrisno, S. (2020). Misconceptions in Rate of Reaction and Their Impact on Misconceptions in Chemical Equilibrium. *European Journal of Educational Research*, *9*(4), 1405-1423. Retrieved from http://eprints.unm.ac.id/id/eprint/30421

Laliyo, L. A. R., Tangio, J. S., Sumintono, B., Jahja, M., & Panigoro, C. (2020). Analytic Approach of Response Pattern of Diagnostic Test Items in Evaluating Students' Conceptual Understanding of Characteristics of Particle of Matter. *Journal of Baltic Science Education*, *19*(5), 824-841. https://doi.org/10.33225/jbse/20.19.824

Muchyar, L. D. H., Widodo, A., & Riandi, R. (2015). Profil Perubahan Konseptual Siswa pada Materi Kependudukan dan Pencemaran Lingkungan. *Jurnal Pengajaran Matematika dan Ilmu Pengetahuan Alam,* *20*(1), 65–75. https://doi.org/10.18269/jpmipa.v20i1.36201

Nofiana, M., & Julianto, T. (2017). Profil Kemampuan Literasi Sains Peserta Didik SMP di Kota Purwokerto Ditinjau dari Aspek Konten, Proses, dan Konteks Sains. *Jurnal Sains Sosial dan Humaniora,* *1*(2), 77-84. http://dx.doi.org/10.30595/jssh.v1i2.1682

Nurulwati, N., & Rahmadani, A. (2019). Perbandingan Hasil Diagnostik Miskonsepsi Menggunakan Threetier dan Fourtier Diagnostic Test pada Materi Gerak Lurus. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *7*(2), 101-110. https://doi.org/10.24815/jpsi.v7i2.14436

Nurulwati, N., Veloo, A., & Ali, R. M. (2014). Suatu Tinjauan tentang Jenis-Jenis dan Penyebab Miskonsepsi Fisika. *Jurnal Pendidikan Sains Indonesia*, *2*(1), 87-95. Retrieved from https://jurnal.usk.ac.id/JPSI/article/view/7636/6264

OECD. (2019a). *PISA 2018 Results (Volume I): What Students Know and Can Do*. Paris: PISA, OECD Publishing. https://doi.org/10.1787/5f07c754-en

OECD. (2019b). *PISA 2018 Results (Volume II): Where All Students Can Succeed*. Paris: PISA, OECD Publishing. https://doi.org/10.1787/b5fd1b8f-en

Park, M., & Liu, X. (2021). An Investigation of Item Difficulties in Energy Aspects across Biology, Chemistry, Environmental Science, and Physics. *Research in Science Education*, *51*, 43-60. https://doi.org/10.1007/s11165-019-9819-y

Pujayanto, P., & Haryani, F. F. (2022). Analisis Kesalahan Mahasiswa pada Pemahaman Soal tentang Rangkaian Listrik Arus Searah Berdasarkan Newman's Error Analysis (NEA). *Jurnal Sains Edukatika Indonesia (JSEI)*, *4*(2). Retrieved from https://jurnal.uns.ac.id/jsei/article/download/70939/39613

Qodriyah, N. R. L., Rokhim, D. A., Widarti, H. R., & Habiddin, H. (2020). Identifikasi Miskonsepsi Siswa Kelas XI SMA Negeri 4 Malang pada Materi Hidrokarbon Menggunakan Instrumen Diagnostik Three Tier. *Jurnal Inovasi Pendidikan Kimia*, *14*(2), 2642-2651. https://doi.org/10.15294/jipk.v14i2.24293

Rahim, A., Hernani, H., & Mudzakir, A. (2016). Pengembangan Alat Ukur Penilaian Literasi Sains pada Konten Struktur Atom dan Ikatan Kimia Menggunakan Konteks Wayang Kulit. *Jurnal Penelitian Pendidikan Kimia: Kajian Hasil Penelitian Pendidikan Kimia*, *3*(2), 138-146. https://doi.org/10.36706/jppk.v3i2.8160

Ritonga, N., Gultom, H. S. B., & Sari, N. F. (2018). Miskonsepsi Siswa Biologi tentang Materi Sistem Respirasi pada SMA Negeri Se-Kabupaten Labuhanbatu. *Jurnal Pelita Pendidikan*, *6*(1), 42-46. https://doi.org/10.24114/jpp.v6i1.9172

Rohman, S., Rusilowati, A., & Sulhadi, S. (2017). Analisis Pembelajaran Fisika Kelas X SMA Negeri di Kota Cirebon Berdasarkan Literasi Sains. *Physics Communication*, *1*(2), 12-18. https://doi.org/10.15294/physcomm.v1i2.10402

Rokhim, D. A., Rahayu, S., & Dasna, I. W. (2023). Analisis Miskonsepsi Kimia dan Instrumen Diagnosisnya: Literatur Review. *Jurnal Inovasi Pendidikan Kimia*, *17*(1), 17-28. https://doi.org/10.15294/jipk.v17i1.34245

Rusilowati, A., Kurniawati, L., Nugroho, S. E., & Widiyatmoko, A. (2016). Developing an Instrument of Scientific Literacy Assessment on the Cycle Theme. *International Journal of Environmental and Science Education*, *11*, 5718-5727. Retrieved from http://files.eric.ed.gov/fulltext/EJ1115684.pdf

Setianita, O. T., & Liliawati, W. (2019). Identifikasi Miskonsepsi Siswa SMA pada Materi Pemanasan Global Menggunakan Four–Tier Diagnostic Test dengan Analisis Confidence Discrimination Quotient (CDQ). *Proceedings of the Seminar Nasional Fisika, 1*(1), 186-192. Retrieved from http://proceedings.upi.edu/index.php/sinafi/article/download/585/504

Soeharto, S., Csapó, B., Sarimanah, E., Dewi, F. I., & Sabri, T. (2019). A Review of Students' Common Misconceptions in Science and Their Diagnostic Assessment Tools. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 247-266. http://doi.org/10.15294/jpii.v8i2.18649

Susiati, A., Adisyahputra, A., & Miarsyah, M. (2018). Correlation of Comprehension Reading Skill and Higher-Order Thinking Skill with Scientific Literacy Skill of Senior High School Biology Teacher. *Biosfer: Jurnal Pendidikan Biologi*, *11*(1), 1-12. https://doi.org/10.21009/biosferjpb.11-1.1

Türkoguz, S. (2020). Investigation of Three-Tier Diagnostic and Multiple Choice Tests on Chemistry Concepts with Response Change Behaviour. *International Education Studies*, *13*(9), 10-22. Retrieved from http://files.eric.ed.gov/fulltext/EJ1266489.pdf

Wernecke, U., Schütte, K., Schwanewedel, J., & Harms, U. (2018). Enhancing Conceptual Knowledge of Energy in Biology with Incorrect Representations. *CBE—Life Sciences Education*, *17*(1), ar5. https://doi.org/10.1187/cbe.17-07-0133

Widarti, H. R., Permanasari, A., Mulyani, S., & Rokhim, D. A. (2021). Multiple Representation-Based Learning through Cognitive Dissonance Strategy to Reduce Student's Misconceptions in Volumetric Analysis. *TEM Journal*, *10*(3), 1263. https://doi.org/10.5539/ies.v13n9p10

Yuberti, Y., Suryani, Y., & Kurniawati, I. (2020). Four-Tier Diagnostic Test with Certainty of Response Index to Identify Misconception in Physics. *Indonesian journal of science and mathematics education*, *3*(2), 245-253. https://doi.org/10.24042/ijsme.v3i2.6061

Zulanwari, Z. A. Z., Ramdani, A., & Bahri, S. (2023). Analisis Kemampuan Literasi Sains Siswa SMA terhadap Soal–Soal PISA pada Materi Virus dan Bakteri. *Journal of Classroom Action Research*, *5*(SpecialIssue), 210-216.

https://doi.org/10.29303/jcar.v5iSpecialIssue.4374