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Contents

- Scientific Learning Through The Edu Eco Approach As An Alternative Improving Student Knowledge And Skills
Oktaffi Arinna Manasikana, Noer Afidah, Andhika Mayasari, Gunawan Faizah, M. Nur Tuti Liana, Junaidi 1-13
- Pengaruh Implementasi *Geoboard* Melalui Pendekatan *Open-Ended* Terhadap Peningkatan Kemampuan Eksplorasi Matematis Ditinjau Dari Gender
Martines, Ruslaini, Fita Nelyza 14-29
- Penerapan Metode *Scaffolding* Berbantuan Soal Hots Untuk Meningkatkan Kemampuan Berpikir Kritis Matematis Siswa Pada Materi Trigonometri
Wulandari, Nuraina, Marina Fadhillah, Eri Saputra, Erna Isfayani 30-41
- Pemanfaatan Legenda Aceh Sebagai Pembelajaran Nilai-Nilai Nasionalisme
Asriani, Cut Faizah, Basri, Edi Azwar, Riswan, T. Makmur 42-59
- An analysis of Scientific Literacy Misconception Using FTT to IPA Teachers in Banda Aceh
Muhammad Azzarkasyi, Syamsul Rizal 60-74
- Sosialisasi Pendidikan Kesehatan Melalui Pemanfaatan Jahe Sebagai Sumber Kesehatan Lokal Bagi Penderita Diabetes Mellitus
Asri Jumadewi, Yenni Sasmita, Rasima, Muhammad Ridhwan, Aris Munandar 75-82
- Meningkatkan Penguasaan Kosakata Siswa Dengan Menggunakan Permainan Teka-Teki
Megi, Syahrir, Puspa Sari 83-92
- Pengaruh Penerapan Model Sq3r (Survey, Question, Read, Recite, Review) Terhadap Kemampuan Penguasaan Konsep Siswa
Evi Apriana, Rubiah, Samsul Bahri, Ernawati 93-112
- Peningkatan Pengetahuan Dampak Sampah Terhadap Diare melalui Uji Korelasi Bagi Masyarakat Di Gampong Jawa Kota Madya Banda Aceh
Nurlena Andalia, M. Ridhwan, Roslina, Yuliana, Usman 113-121
- Pembentukan Akhlak Takzeem Keuguree : Pendekatan Sosiologi-Antropology Pada Pendidikan Pasantren Tradisional Aceh
Fahmi Arfan, Ida Hasanah, Mustafa Usman, M. Chalis, Abubakar, Anwar, Irwan M. Nur 122-137
- Efektivitas Metode Mengajar Resiprokal Dalam Meningkatkan Kemampuan Menggiring Bola
Rahmat Putra Perdana 138-147
- Pengaruh Ketulusan (*Altruisme*), Etos Kerja, dan Kepuasan Kerja terhadap Kinerja Guru MI Negeri di Kota Medan
Rizki Utami Batubara, Darwin, Salman Bintang 148-163
- Analysys Of The Use Sarcasm Language Style In Student Interactions
Ririn Rahayu, Trisfayani, Azhari, Dhita Azura 164-178

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Volume 24

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1 - 178

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Forewords

Praise and gratitude to Allah SWT, because of Allah's love for us so that we are still given a long life and can carry out our various daily activities. May all our activities become our acts of worship, Aamiinnn

We are also be proud that the number of submitted manuscripts is quite large, but only a few are acceptable and worthy of publication. This means that Jurnal Serambi Ilmu has become one of the scientific publications that are considered by experts and education enthusiasts.

For this reason, Jurnal Serambi Ilmu is committed to continuing to maintain the quality, service and discipline that applies in scientific publications.

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An analysis of Scientific Literacy Misconception Using FTT to IPA Teachers in Banda Aceh

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Abstract

The purpose of this study was to determine the level of misconception using the Four-Tier Test (FTT) for science teachers. Data collection to obtain the required information was carried out using a diagnostic test instrument which was distributed to 29 teachers who were selected as a sample of the total population of science teachers who teach at SMPN in Banda Aceh. To provide an interpretation by differentiating the level of conception of respondents, they are divided into seven categories based on the combination of answers, namely scientific conceptions (SC), misconceptions (MSC), lack of knowledge guessing (LKG), lack of knowledge deficiency (LKD), false positives (FP), false negatives (FN), cannot be encoded (TKD). The test instrument used in the form of Four-Tier Multiple Choice questions as many as 24 items has been equipped with a choice of the Certainty of Response Index (CRI) confidence level along with the reasons for the answer choices. The results showed that scientific conceptions (SC) 30.46%, misconceptions (MSC) 29.74%, lack of knowledge guessing (LKG) 5.32%, lack of knowledge deficiency (LKD) 8.48%, false positives (FP) 13.07%, false negatives (FN) 12.93%.

Keywords: *Misconception; science teacher; Four-Tier Test.*

INTRODUCTION

Misconceptions or wrong concepts refer to a concept that is in accordance with the scientific understanding or understanding accepted by experts in that field. Misconceptions can be in the form of initial concepts, errors, incorrect relationships between concepts, intuitive ideas or naïve views. Misconceptions are initial concepts as a result of knowledge construction that is inconsistent with scientific concepts (Suryati, et.al, 2020). Broadly speaking, the causes of student misconceptions can be summarized

into five groups, namely students, teachers, textbooks, context and teaching methods. The causes of student misconceptions occur from various things, such as initial preconceptions, abilities, stages of development, interests, ways of thinking, and other friends. Meanwhile, the causes of misconceptions from teachers can be in the form of teacher incompetence, lack of mastery of materials, inappropriate teaching methods or attitudes of teachers who have poor relationships with students (Zafitri, et.al, 2018).

Misconceptions in the field of science often occur in students, especially students who lack the ability to analyze them. This is because the concepts of science lessons are interrelated with one another so that it requires in-depth analytical skills. Diagnostic tests are a technique that is often used in analyzing the level of students' misconceptions based on everyday experiences (Didik, et.al, 2020). Diagnostic tests are usually given using the Certainty Response Index (Azzarkasyi, et.al, 2015), Three Tier Diagnostic Test (Saputra, et.al, 2021), and Four-Tier Diagnostic Test (Erwinsyah, et.al, 2020).

The results of Hermita et al's research on building and applying the Four-Tier Test on static electricity material to diagnose teacher misconceptions have gone through a series of stages and it can be said that the use of Four-Tier Test items can be used to diagnose the level of misconceptions in teachers (Hermita, et.al, 2017).

The combination of respondents' answers for the diagnostic Four-Tier Test is grouped into seven categories as shown in Table 1, namely: a) scientific conceptions (SC) ie when the answers and reasons are correct and the respondent is very sure of the answers and reasons; b) lack of knowledge-guessing (LKG), namely when the answer or reason is correct, but the respondent is unsure of any answer or reason; c) lack of knowledge-deficiency (LKD) means when the reason is correct, but the answer is wrong and the respondent is unsure of any answer or reason; d) false positive (FP), namely when the answer is correct and the reason is wrong, but the respondent is sure of the answer and the reason; e) false negative (FN) is a condition that is opposite to a false positive; f) misconceptions (MSC), namely when the answers and reasons are wrong but the respondent is sure of the answers and reasons; g) cannot be coded, namely when one, two, three or all are not answered (Kurniawati, et.al, 2020).

Table 1
Categories of Four-Tier combination answers

No	Option	Confidence	Reason	Confidence	Category
1	Correct	Sure	Correct	Sure	SC
2	Correct	Sure	Wrong	Sure	FP
3	Wrong	Sure	Correct	Sure	FN
4	Wrong	Sure	Wrong	Sure	MSC
5	Correct	Sure	Correct	Not Sure	LKG
6	Correct	Not Sure	Correct	Sure	LKG
7	Correct	Not Sure	Correct	Not Sure	LKG
8	Correct	Sure	Wrong	Not Sure	LKG

9	Correct	Not Sure	Wrong	Sure	LKG
10	Correct	Not Sure	Wrong	Not Sure	LKG
11	Wrong	Sure	Correct	Not Sure	LKG
12	Wrong	Not Sure	Correct	Sure	LKG
13	Wrong	Not Sure	Correct	Not Sure	LKG
14	Wrong	Sure	Wrong	Not Sure	LKD
15	Wrong	Not Sure	Wrong	Sure	LKD
16	Wrong	Not Sure	Wrong	Not Sure	LKD
17	If one, two, three or all are not answered				Cannot be encoded

SC = scientific conceptions, FP = false positive, FN= false negative, MSC = misconceptions, LKG = lack of knowledge-guessing, LKD = lack of knowledge-deficiency

CRI is used to measure the level of confidence in answering each question given (Taufiq, 2012). The level of self-confidence that is developed is in the range of one to six according to research that has been previously conducted by (Wulandari, et.al, 2017). This level of confidence will make it easier and save time in analyzing the misconceptions of respondents (Annisak, et.al, 2017). With the development of a diagnostic Four-Tier Test with CRI, the misconceptions of the respondents can be identified properly. Kurniasih (2017) states the level of confidence in CRI is presented in Table 2, namely:

Table 2
 CRI Confidence Scale

Category	Scale	Confidence Level
Guess	0	Low/Not sure
Very unsure	1	
Not sure	2	
Sure	3	High/Sure
Somewhat sure	4	
Very sure	5	

METHOD

Data collection to obtain the required information was carried out using a diagnostic test instrument which was distributed to 29 teachers who were selected as a sample of the total population of science teachers teaching at SMPNs throughout Banda Aceh. The test instrument used was a Four-Tier Multiple Choice question consisting of 24 items which were equipped with a choice of CRI confidence level along with the reasons for the selected answers.

To provide an interpretation of the level of misconceptions, a diagnostic Four-Tier Test was used by differentiating the respondent's level of conception into seven categories based on a combination of answers (Gurel, et.al, 2015). Each question has one correct answer and one correct reason. Other options contain alternative conceptions. Therefore, respondents' responses were analyzed based on alternative conceptions (Anggrayni, et.al, 2019). Respondents' answers were grouped into seven categories as shown in Table 1. The level of understanding can be categorized by calculating the % of answers from each category for each question using the following equation;

$$PJ = \frac{n_x}{n_s} \cdot 100\%$$

Where PJ is the % answers of each question, nx is the number of students belonging to the category scientific conceptions (SC), misconception (MSC), lack of knowledge guessing (LKG), lack of knowledge deficiency (LKD), false positives (FP), false negatives (FN), cannot be encoded (TKD), dan ns is the number of respondents.

RESULTS AND DISCUSSION

Research data collection was conducted on science teachers at SMPNs across the city of Banda Aceh using diagnostic test instruments and documentation. The test used is a Four-Tier Multiple Choice question consisting of 24 questions. The answer sheet provides answer columns, Certainty of Response Index (CRI) and answer reasons. From a number of study populations, 29 teachers were sampled from several SMPNs throughout the city of Banda Aceh. The research results obtained by the average value of respondents by category scientific conceptions (SC), misconception (MSC), lack of knowledge guessing (LKG), lack of knowledge deficiency (LKD), false positives (FP), false negatives (FN), cannot be encoded (TKD).

The results of data analysis from a total of 24 items that were distributed, there were 5 (five) items that became the focus of attention. This is because the five item questions obtained the highest level of misconceptions. The five item questions are item number 7 (seven), 9 (nine), 11 (eleven), 16 (sixteen), 22 (twenty-two). The percentage level of misconceptions obtained is as follows:

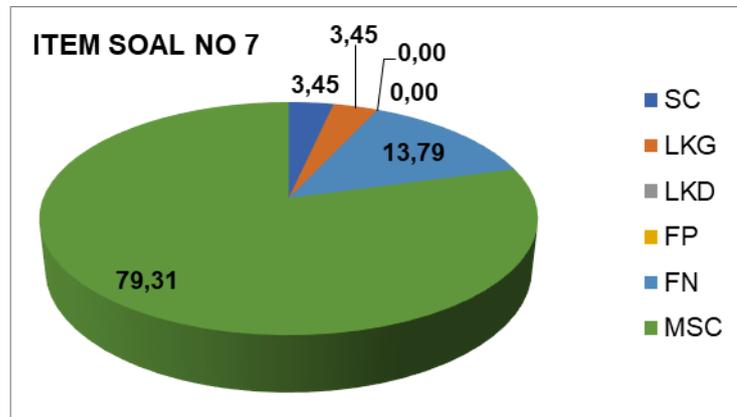


Figure 1. Percentage of Category Indicator Items Question Number Seven

From Figure 1 it is found that 23 respondents who experienced high misconceptions (MSC) 79.31%, scientific conceptions (SC) 3.45%, lack of knowledge guessing (LKG) 3.45%, lack of knowledge deficiency (LKD) 0.00%, false positives (FP) 0.00%, false negatives (FN) 13.79%. These results indicate that apart from misconceptions, only one person whose answer is in accordance with scientific conceptions and does not know the concept and guesses, while the other four respondents are negatively wrong, namely the answer is wrong because it is correct but the level of confidence is high. This item is a study of electrical material that asks about testing a flashlight that doesn't work anymore because it's old.

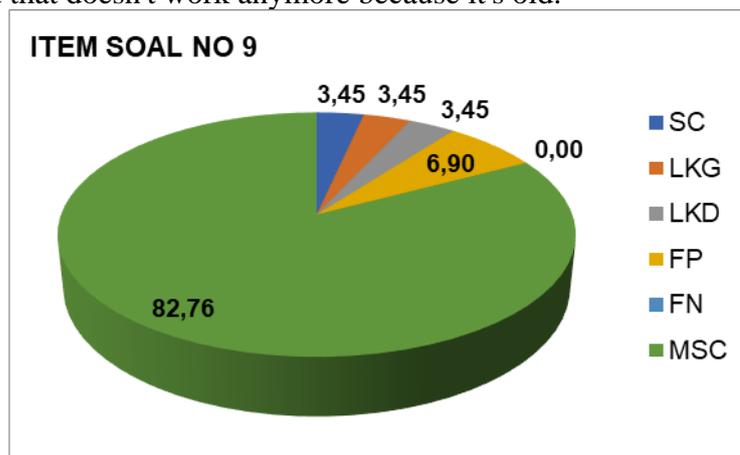


Figure 2. Percentage of Category Indicator Items for Question Number Nine

Figure 2 is the percentage of item number nine. From the picture above it is found that 24 respondents who experienced high misconceptions (MSC) 82.76%, scientific conceptions (SC) 3.45%, lack of knowledge guessing (LKG) 3.45%, lack of knowledge

deficiency (LKD) 3.45%, false positives (FP) 6.90%, false negatives (FN) 0.00%. The results of the analysis on this item show that apart from misconceptions, only one respondent whose answer was found to have a scientific conception, did not know the concept but guessed and lacked knowledge of the concept. while the other two are positive false, namely the answer is correct because it is wrong but the level of confidence is high. The item of this question is the study of population development from animal life in a research conducted for 30 years.

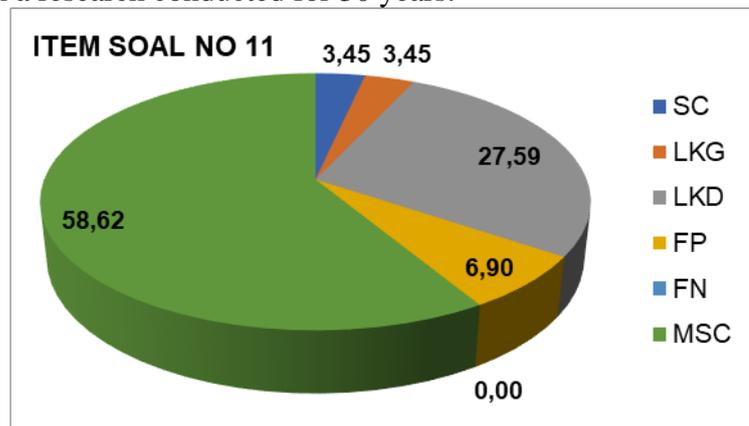


Figure 3. Percentage of Indicator Category Items for Question Number Eleven

Figure 3 shows the percentage of item number eleven. From the figure it is found that 17 respondents who experienced high misconceptions (MSC) 58.62%, scientific conceptions (SC) 3.45%, lack of knowledge guessing (LKG) 3.45%, lack of knowledge deficiency (LKD) 27.59%, false positives (FP) 6.90 %, false negatives (FN) 0.00%. The results of the analysis on this item show that apart from misconceptions, only one respondent whose answer was found to have a scientific conception, did not know the concept but guessed, and eight respondents lacked knowledge of the concept. while the other two are positive false, namely the answer is correct because it is wrong but the level of confidence is high. This problem examines related to data collection about how the battery voltage varies after a few weeks which is displayed in a voltage (voltage) graph.

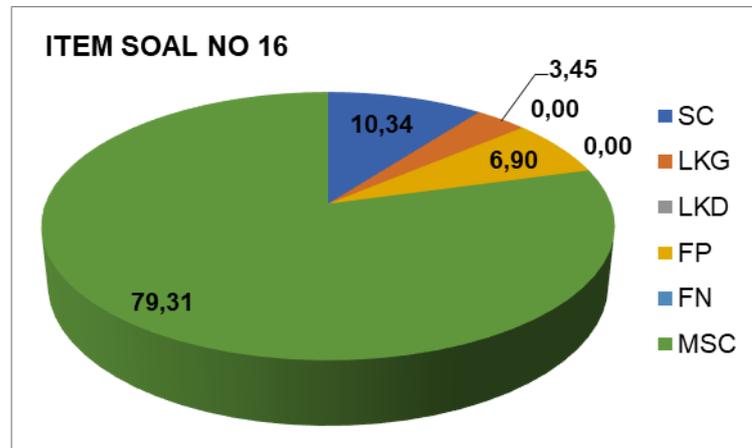


Figure 4. Percentage of Category Indicator Items for Question Number Sixteen

Figure 4 shows the percentage of item number sixteen. From the figure it is found that 23 respondents who experienced high misconceptions (MSC) 79.31%, scientific conceptions (SC) 10.34%, lack of knowledge guessing (LKG) 3.45%, lack of knowledge deficiency (LKD) 0.00%, false positives (FP) 6.90 %, false negatives (FN) 0.00%. The results of the analysis on this item show that apart from misconceptions, three respondents whose answers were found to have scientific conceptions, one respondent who did not know the concept but guessed. while the other two are positive false, namely the answer is correct because it is wrong but the level of confidence is high. This item examines a hypothesis that causes a reason why wood floats in water according to the perspective of a scientist.

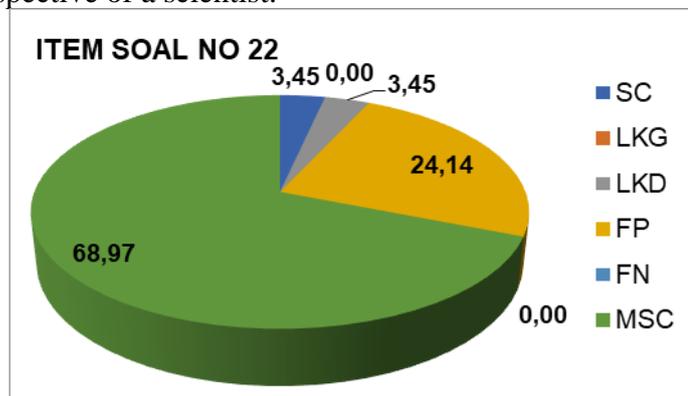


Figure 5. Percentage of Category Indicator Items for Question Number Twenty Two

Figure 5 shows the percentage of item number twenty two. From the figure it is found that 20 respondents who have high misconceptions (MSC) 68.97%, scientific

conceptions (SC) 3.45%, lack of knowledge guessing (LKG) 0.00%, lack of knowledge deficiency (LKD) 3.45%, false positives (FP) 24.24 %, false negatives (FN) 0.00%. The results of the analysis on this item show that apart from misconceptions, only one respondent whose answer was found to have a scientific conception and a lack of knowledge of the concept. while the other seven positive respondents were wrong, namely the answer was correct because it was wrong but the level of confidence was high. This item examines the observations of a naturalist who provides a conclusion about the causes of winter that affect bear hibernation, bird migration and changes in leaf color that occur.

The results of the data analysis of the overall percentage in each indicator category from the 24 item questions given to 29 respondents as shown in the following figure:

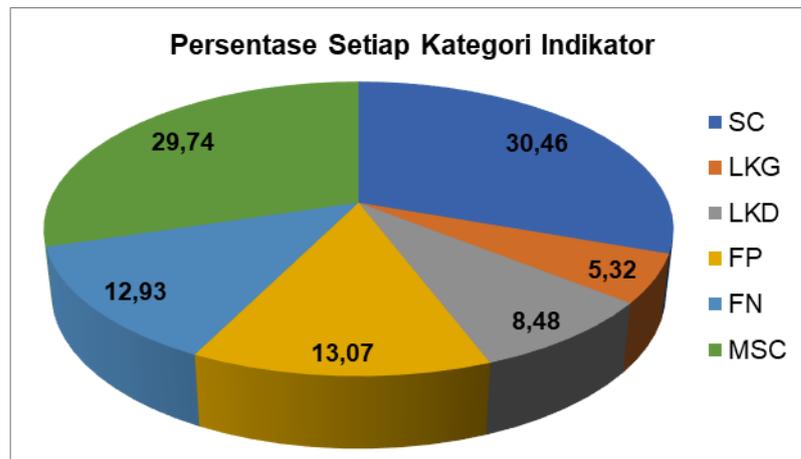


Figure 6. Percentage of Each Indicator Category

Figure 6 shows the percentage of each indicator category analyzed from the 24 item items given to 29 respondents who were taken as samples in the study. Based on the picture above, it is found that the average of each indicator category is; (MSC) 29.74%, scientific conceptions (SC) 30.46%, lack of knowledge guessing (LKG) 5.32%, lack of knowledge deficiency (LKD) 8.48%, false positives (FP) 13.07%, false negatives (FN) 12.93% . These results indicate that the level of misconceptions that occur is still in the low category and there are already many teachers who have scientific conceptions that are in accordance with the opinions of experts. Some teachers also still don't know the concept, so they guess in their answers and also lack knowledge of the concept being asked. Meanwhile, there are also some who answer positively incorrectly, namely the answer is correct because it is wrong but the level of confidence is high and negatively incorrect, namely the answer is wrong because it is correct but the level of confidence is high.

The results of data analysis on scientific literacy misconceptions in science teachers using a test in the form of Four-Tier Multiple Choice questions totaling 24

items. The answer sheet provides answer columns, Certainty of Response Index (CRI) and answer reasons. From a number of research populations, 29 teachers were taken as a sample from several SMPNs in Banda Aceh. To find out the interpretation of the level of scientific literacy misconceptions by categorizing conceptions (SC), misconceptions (MSC), lack of knowledge guessing (LKG), lack of knowledge deficiency (LKD), false positives (FP), false negatives (FN), cannot be encoded (TKD). Meanwhile, the level of Scientific Literacy ability based on The Program for International Student Assessment (PISA), refers to one of the dimensions of scientific literacy, namely the competency aspect. The Competency Aspect consists of three scientific competencies, namely explaining phenomena scientifically (A), designing and evaluating scientific investigations (B) and interpreting data and evidence scientifically (C). Misconceptions of scientific literacy in each respondent can be seen in Table 1 below.

Table.1 Results of Scientific Literacy Misconception Analysis

Respondents	TOTAL								
	Misconceptions of Scientific Literacy			MSC	SC	LKG	LKD	FP	FN
	A	B	C						
R 1	2	2	4	8	5	3	4	2	2
R 2	2	2	4	8	4	4	4	2	2
R 3	2	2	4	8	5	3	4	2	2
R 4	2	2	1	5	7	1	4	5	2
R 5	2	2	1	5	7	1	4	5	2
R 6	2	2	1	5	7	1	4	5	2
R 7	1	1	4	6	9	2	1	4	2
R 8	2	0	4	6	5	2	4	5	2
R 9	4	2	5	11	5	0	1	4	3
R 10	2	0	4	6	5	1	4	6	2
R 11	2	0	3	5	3	4	5	5	2
R 12	2	0	4	6	5	1	5	5	2
R 13	2	1	4	7	6	1	4	5	1
R 14	2	5	4	11	4	0	1	3	5
R 15	4	5	3	12	3	0	0	5	4
R 16	2	1	5	8	13	0	0	1	2
R 17	2	3	2	7	9	0	0	2	6
R 18	3	3	3	9	9	0	0	0	6
R 19	3	3	2	8	8	0	0	1	7
R 20	3	3	3	9	9	1	0	0	5
R 21	3	3	3	9	9	0	0	0	6
R 22	3	3	5	11	9	0	0	0	4
R 23	2	3	3	8	9	0	0	0	7

R 24	0	1	0	1	0	11	9	0	3
R 25	1	2	3	6	13	0	0	3	2
R 26	1	2	2	5	11	1	1	4	2
R 27	1	2	3	6	13	0	0	4	1
R 28	0	2	3	5	10	0	0	7	2
R 29	1	2	3	6	10	0	0	6	2

Based on table 1 above, it shows that all respondents experienced misconceptions in science lessons in all aspects of scientific literacy. In the aspect category of explaining phenomena scientifically (A) misconceptions of scientific literacy are caused by the ability to apply scientific knowledge in a given situation, describe relevant information and explanations, and explain and predict appropriate results (Rini et al, 2021). In the process of learning science teachers need to understand basic concepts and describe phenomena and be able to explain the concepts being taught in accordance with scientific studies.

Misconceptions of scientific literacy in the aspect category of designing and evaluating scientific investigations (B) and interpreting data and evidence scientifically (C). In the process of teaching science learning teachers must have scientific investigation skills including scientific methods (scientific processes), so that teachers can teach students to develop their scientific attitudes and thinking skills (Indrawati et al, 2022). The existence of scientific investigation activities in the science learning process will foster students' critical thinking skills, this is because if students' competence in scientific investigations is low, their critical thinking skills will also be low.

Misconceptions on aspects B and C are due to the teacher's lack of knowledge of the material they understand so that teachers are also difficult to interpret an investigation of the material and cannot prove it scientifically. The problems faced by these teachers have an impact on students so that they cannot evaluate a scientific investigation and also cannot interpret research data and evidence scientifically. Competency category aspects of designing and evaluating scientific investigations (B) to critically evaluate reports of scientific findings and investigations. This competency demonstrates students' ability to identify and distinguish questions that can be investigated scientifically, propose and evaluate ways to explore scientifically given questions, and be able to explain and evaluate how scientists ensure data reliability, objectivity, and generalizability of explanations described in PISA 2015 (OECD, 2017).

Meanwhile, the competency aspect category interprets data and evidence scientifically (C) to analyze and evaluate data, claims, and arguments in various representations and draw appropriate scientific conclusions. This competency demonstrates the ability to transform data from one representation to another; analyze and interpret data and draw appropriate conclusions; identify assumptions, evidence, and reasons in texts related to science; distinguish between arguments based on scientific evidence and theory and based on other considerations; and evaluate scientific

arguments and evidence from various sources such as newspapers, journals and the internet (OECD, 2017). The implementation of scientific evidence is one of the skills that science teachers must have, because in this aspect category the teacher must be able to teach his students to be able to interpret findings as evidence to draw conclusions. In addition, this competency also requires students to provide evidence and conclusions, diagrams or others. Therefore, students must describe the correlation between evidence and conclusions (Yenni. *et all*, 2016).

Based on the problems described above, the misconception of scientific literacy is due to the diverse backgrounds of science teachers. This can be seen from the fact that most of the teachers who teach in junior high schools are teachers who graduated from biology and physics education so that in practice the integrated science learning referred to in the curriculum still experiences many obstacles. This question was also obtained based on the results of interviews with science teachers at the time of research data collection. As a result, teachers are still unable to carry out integrated science learning on some material that is not in accordance with the fields of their graduates.

Harefa, (2022) states that the obstacle faced by integrated science teachers in teaching integrated science is the difficulty in teaching subject themes that are not the teacher's educational background, for example integrated science teachers with a biology background find it very difficult to teach physics material, especially those related to formulation of equations and analysis of problems in physical phenomena. Likewise, many practicum activities are dominated by the scientific field due to limitations in using data analysis tools and techniques, even though physics practicum is carried out but only at the exploratory level, not up to how to find concepts and analyze good and correct physics or chemical problems. Likewise with teachers with a background in physics, there will be little difficulty in teaching biology or chemistry which is more about rote learning.

CONCLUSION

Misconceptions are initial concepts as a result of knowledge construction that is inconsistent with scientific concepts. The cause of the emergence of misconceptions in science teachers at the junior high school level is because some of the teachers who teach are not in accordance with their scientific fields. So that the understanding of the conception that occurs is not in accordance with the scientific conception as explained by experts in the scientific field. This is also in line with research conducted by other researchers which states that the causes of teacher misconceptions can be in the form of teacher incompetence, lack of mastery of the material, inappropriate teaching methods or the attitude of the teacher who has a poor relationship with students.

Scientific Literacy ability based on The Program for International Student Assessment (PISA) for science teachers, refers to one of the dimensions of scientific literacy, namely the competency aspect. The Competency Aspect consists of three scientific competencies, namely explaining phenomena scientifically, designing and evaluating scientific investigations and interpreting data and evidence scientifically. So it can be concluded that the scientific literacy competence of junior high school science teachers in Banda Aceh City is in the medium category with a percentage of 48.48%. ability based on competence to explain phenomena scientifically is in the medium category with a percentage of 46.55%, competence in designing and evaluating scientific investigations is in the moderate category with a percentage of 61.64%, and competence in interpreting data and evidence scientifically is in the moderate category with a percentage of 37.24%.

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