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Analysis of Science Literacy Skill of Chemistry Education Students of Tanjungpura University

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Abstract: Analysis of Science Literacy Skill of Chemistry Education Students of Tanjungpura University. This research employs a quantitative descriptive method which aims to analyze the scientific literacy skills of students. Fourty-three students in the fourth year of the 2020/2021 academic year participated in this study. Scientific literacy tests, questionnaires and interviews were used as to collect the data. The scientific literacy test is used to measure aspects of knowledge and competence which adopted from the Dutch National Chemistry Exam consisted of 16 questions. The 11 statements in the questionnaires are used to measure the aspects of attitudes. Interviews are used to confirm the results of both test and questionnaire. Data were analyzed by calculating the test scores and the percentage of students' answers on the questionnaire. Based on data analysis, students' scientific literacy skills of knowledge and competence aspect are classified as low with an average score of 43 and 38, while the attitude aspect is classified as moderate with an average percentage of 75%. The results of the analysis obtained can be used as a reference for the development of students' scientific literacy skills that can be done through the integration of scientific literacy in the learning process and in the use of the learning media.

Keywords: science literacy skills, prospective chemistry teacher, quantitative descriptive

Abstrak: Analisis Kemampuan Literasi Sains Mahasiswa Program Studi Pendidikan Kimia Universitas Tanjungpura. *Penelitian ini merupakan penelitian deskriptif kuantitatif yang bertujuan untuk menganalisis kemampuan literasi sains mahasiswa. Sebanyak 43 orang mahasiswa tahun keempat pada tahun akademik 2020/2021berpartisipasi dalam penelitian ini. Tes literasi sains, angket dan wawancara digunakan untuk mengumpulkan data. Tes literasi sains digunakan untuk mengukur aspek pengetahuan dan kompetensi yang diadopsi dari Ujian Kimia Nasional Belanda yang terdiri dari 16 soal. Sebelas pernyataan dalam angket untuk mengukur aspek sikap. Wawancara digunakan untuk mengkonfirmasi hasil tes dan angket. Analisis data diperoleh dengan menghitung nilai tes dan persentase jawaban mahasiswa pada angket. Berdasarkan analisis data, kemampuan lierasi sains mahasiswa pada aspek pengetahuan dan kompetensi tergolong rendah dengan nilai rata-rata sebesar 43 dan 38, sedangkan aspek aspek sikap tergolong sedang dengan persentase rata-rata sebesar 75%. Hasil analisis yang diperoleh dapat digunakan sebagai referensi untuk pengembangan kemampuan literasi sains mahasiswa yang dapat dilakukan melalui integrasi literasi sains dalam proses pembelajaran maupun media pembelajaran.*

Kata kunci: *kemampuan literasi sains, calon guru kimia, deskriptif kuantitatif*

▪ INTRODUCTION

The 21st century has been an era marked by rapid advances in various fields, including innovation in science and information technology. The development of information technology has greatly influenced various aspects of human life, specifically in the field of education (Wiyono, 2015). This development has led various countries to competitively improve their quality, reliable and globally competitive human resources, particularly in terms of thinking, expertise, and skills (Kristyowati & Purwanto, 2019). Furthermore, this development will certainly contribute to positive or negative impacts depending on the individual recipient. A wide range of problems that are generated from local, national, and global issues are considered as one of these negative impacts. Therefore, these developments may be handled wisely by improving the quality of human resources. In the 21st century, students are expected to be competitive on a global scale (Irmita, 2018). Education is able to provide an important role in developing the quality of human resources for the next generation of the nation who are capable of rational thoughts and actions on developing issues in society and are able to utilize their knowledge and understanding to solve problems (Anjarsari, 2014).

The Program for International Student Assessment (PISA) defines scientific literacy as the ability to engage with science-related issues, and with scientific ideas including the ability to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically (OECD, 2014). Scientific literacy is defined as a person's ability to ask, find, or determine answers to questions arising from their own curiosity in regards to everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena (Dani, 2009).

An international research conducted by PISA measures students' reading, mathematics and scientific literacy levels. Indonesia's scientific literacy achievements from 2000 to 2018 based on the results of the PISA survey are presented in Table 1 (Harususilo, 2019b; Nugrahanto & Zuchdi, 2019) and scientific literacy scores in conformity with country rankings based on the results of the PISA survey are presented in Table 2 (Harususilo, 2019a).

Table 1. Scores and rankings of Indonesian scientific literacy in 2000-2018

Year	Score	Ranking
2000	393	39/41
2003	395	39/40
2006	393	48/56
2009	383	61/65
2012	382	64/65
2015	403	60/72
2018	396	71/76

Table 2. Scores and rankings of scientific literacy of countries in the world based on PISA in 2018 (with an average score of 489)

No	Country	Score	No	Country	Score	No	Country	Score
1	China	590	27	Norway	490	53	Romania	426
2	Singapore	551	28	Austria	490	54	Uruguay	426
3	Macao	544	29	Latvia	489	55	Thailand	426
4	Estonia	530	30	Spain	483	56	Bulgaria	424
5	Japan	529	31	Lithuania	482	57	Mexico	419
6	Finland	522	32	Hungary	481	58	Qatar	419
7	Korea	519	33	Russia	478	59	Albania	417
8	Canada	518	34	Luxembourg	477	60	Costa Rica	416
9	Hong Kong	517	35	Iceland	475	61	Montenegro	415
10	Taipei	516	36	Croatia	472	62	Colombia	413
11	Poland	511	37	Belarus	471	63	Macedonian	413
12	New Zealand	508	38	Ukraine	469	64	Brazil	404
13	Slovenia	507	39	Italy	468	65	Argentina	404
14	England	505	40	Turkey	468	66	Peru	404
15	Australia	503	41	Slovak Republic	464	67	Bosnia	398
16	German	503	42	Israel	462	68	Azerbaijan	398
17	Netherlands	503	43	Malta	457	69	Kazakhstan	397
18	United States of America	502	44	Greece	452	**70**	**Indonesia**	**396**
19	Sweden	499	45	Chile	444	71	Saudi Arabia	386
20	Belarus	499	46	Serbia	440	72	Lebanese	386
21	Czech Republic	497	47	Cyprus	439	73	Georgia	383
22	Ireland	496	48	Malaysia	438	74	Morocco	377
23	Switzerland	495	49	United Arab Emirates	434	75	Panama	365
24	Denmark	493	50	Brunei Darussalam	431	76	Kosovo	365
25	France	493	51	Jordan	429	77	Philippines	357
26	Portugal	492	52	Moldova	428	78	Dominican Republic	336

Referring to the data presented in Table 1 and Table 2, it could be assumed that the scientific literacy ability of Indonesian students need to be highly improved for the intention to compete at the international level. In the last few periods, Indonesia tended to be in bottom rank compare to other countries. This position shows that the scientific literacy ability of Indonesian students is still relatively low compared to other countries (Fuadi et al., 2020). The results of the scientific literacy ability of students from all participating countries published by PISA from 2000 to 2018 indicated that Indonesian students scored among the lowest (Setiadi, 2013). By having a scientific literacy score of 400 points, Indonesian students are only able to remember scientific knowledge based on simple facts (such as names, facts, terms, simple formulas), and utilize general scientific knowledge to draw or evaluate a conclusion (Rustaman, 2003).

The low scientific literacy ability of students in Indonesia is certainly influenced by several factors. The gap between scientific learning in schools and the demands of

PISA has been stated by previous research (Kurnia et al., 2014). Moreover, a number of teachers are still identified as having lack of proficiency in scientific literacy. Thus, the current teachers tend to be incapable of conducting the teaching and learning process based on the scientific literacy. Learning aids such as teaching materials and evaluation instruments are also markedly not developed based on scientific literacy. The teaching and learning process conducted by the teacher only refers to the concepts and materials of books and worksheets, without employing other strategies such as experiments or discussions (Prabowo et al., 2018).

The teacher is required to improve the scientific literacy skill of Indonesian students to be competitive in the 21st century. The low level of scientific literacy in Indonesia may be improved by facilitating positive changes in the field of education (Laksono, 2018). Education contributes a major role in increasing students' scientific literacy skill. Prospective educators are responsible for developing and training students' scientific literacy skill in the future. Therefore, prospective chemistry teacher are highly demanded for having qualified scientific literacy ability (Laksono, 2018).

Student's scientific literacy ability is assessed according to the PISA scientific literacy assessment framework which includes three aspects, specifically knowledge, competence, and attitude. The scientific literacy assessment does not only assess context, but also examines the four inter-related aspects of context: knowledge, competence, and attitudes (Aryani et al., 2016).

The Chemistry Education Study Program at Tanjungpura University is one of the institutions producing prospective chemistry teachers who are expected to have qualified scientific literacy ability. Research on the scientific literacy ability of students in the chemistry education study program was conducted at Tanjungpura University, and the results showed that the average scientific literacy ability of students was in the medium category, specifically the scientific literacy content was in the medium category, the process of science and the context of scientific literacy were in low the category (Enawaty, 2021). Furthermore, research on scientific literacy ability had also been conducted on students of the chemistry education study program at UIN Raden Fatah in Palembang. The results of this research indicated that students' scientific literacy abilities were included in the medium category (Laksono, 2018). Therefore, research on the analysis of the scientific literacy ability of the Chemistry Education Study Program students at Tanjungpura University was highly required to be carried out with the aim of analyzing the scientific literacy abilities of Chemistry Education students at Tanjungpura University. Consequently, the results of this research were enabled to be used as self-motivations to improve scientific literacy ability, as feedbacks for lecturers to improve students' scientific literacy ability and as considerations in improving the quality of learning.

▪ METHOD

This research employs a quantitative descriptive design. There is no treatment to the research subject. Fourty-three students in the fourth year of the 2020/2021 academic year participated in this study. The participants consist of 8 male and 35 female. The research subjects consisted of three classes and were included according to the students' willingness to become participants. The research was conducted by providing scientific literacy test and scientific literacy attitude questionnaires distributed to students involved in the research. The test was performed in 120 minutes, by filling out the questions and

questionnaires by means of an electronic form, which is *Google Form*. Subsequently, interviews were conducted on six students in a semi-structured manner.

The research instruments used by the researcher consisted of a scientific literacy test and a questionnaire, and an interview guide. The test instrument used was adopted from the questions of the National Chemistry Examination in the Netherlands by *Dolf Witte* and *Kees Beers* in 2003. These instruments were utilized to measure two aspects of scientific literacy, particularly knowledge and competence related to context by providing 16 questions in three tasks. The distribution of questions on the knowledge aspect and competence aspect is presented in Table 3 and Table 4.

Table 3. Distribution of knowledge aspects

Knowledge Aspect	Question Number
Content knowledge	1, 2, 3, 4, 10, 11, 12
Procedural knowledge	5, 6, 7, 9
Epistemic knowledge	8, 13, 14, 15, 16

Table 4. Distribution of competency aspects

Competency Aspect	Question Number
Explain phenomena scientifically	1, 2, 3, 13, 15
Evaluate and design scientific enquiry	8, 14, 16
Interpret data and evidence scientifically	4, 5, 6, 7, 9, 10, 11, 12

The maximum score for each question item is presented in Table 5. The test instruments used in this research had been previously translated from English into Indonesian. Furthermore, an online content exam was successfully made which was then validated by three science lecturers and two language experts.

Table 5. The maximum score for each question

Question Number	Maximum Score
1	2
2	1
3	2
4	3
5	3
6	3
7	3
8	2
9	3
10	3
11	2
12	3
13	2
14	2
15	5
16	2

Questionnaires were utilized to measure attitudes aspects of scientific literacy with three indicators, specifically interest in science, appreciation for scientific approaches in

any enquiry, and environmental awareness as stated in 11 statement items. These questionnaires were developed based on the attitude aspect indicators according to PISA, which was initiated by compiling a questionnaire outline, determining the measurement scale in the questionnaire which was then validated by three science lecturers and two language experts. The scale used in the questionnaire was a Likert scale with five alternative answers: always, often, sometimes, almost never, and never. The scoring of each alternative answer depends on the content of the statement. The scoring of each alternative answer is presented in Table 6.

Table 6. Scores of alternative answer of the statement items

Alternative answer	Statement Items	
	Positive	**Negative**
Always	5	1
Often	4	2
Sometimes	3	3
Almost never	2	4
Never	1	5

The results of expert validation were determined by means of the *Gregory* formula. Regarding to the results of the validation in terms of content and language, the research instruments, both the scientific literacy attitude questionnaire and the scientific literacy test items were declared feasible to use. Furthermore, the test instrument questions and questionnaires were then analyzed using the *Alpha Cronbach* formula to determine the reliability of each instrument. An instrument is declared to be reliable if it has an *Alpha* coefficient of 0.6 or more (Zahra & Rina, 2018). Referring to the results of data analysis, the research instruments provided *Cronbach's Alpha* coefficient of 0.624 for the questionnaire and 0.782 for the test questions. Therefore, the questionnaire and test items were declared reliable as instruments in this research.

Semi-structured interviews were conducted on chemistry education students as research samples to explore deeply the answers from students. Interviews were only conducted on six students who were considered able to provide detailed information regarding to the answers to the test questions.

The research data were analyzed by calculating the test scores and the percentage on the scientific literacy attitude questionnaire. The score of the test results was obtained by applying the calculation formula as follows.

$$\text{Score} = \frac{Acquisition\ score}{Maximum\ score}\ x\ 100$$

Moreover, the scores and percentages of these achievements were respectively compared with the provisions as shown in Table 7 (Saija, 2019).

Table 7. Classification of scientific literacy ability categories sains

Provision	Category
76-100	High
56-75	Medium
<56	Low

▪ RESULT AND DISCUSSION

The scientific literacy ability of 8th semester students at the Chemistry Education Study Program, Tanjungpura University was obtained from the average score of knowledge and competence aspects. The average percentage on the attitude aspect can be seen in Table 8. Referring to the acquisition of test scores, students' scientific literacy ability in the aspects of knowledge and competence can be classified into three categories, particularly high, medium, and low. The distribution of students' scientific literacy categories on the aspects of knowledge and competence is presented in Figure 1.

Table 8. Scientific literacy ability in aspects of knowledge, competence, and attitude

Scientific Literacy Aspect	Result	Information
Knowledge	43	Score
Competence	38	Score
Attitude	75	Percentage

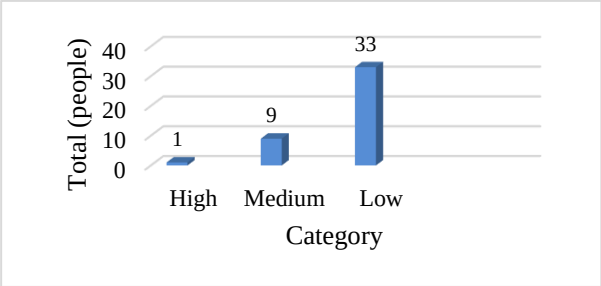


Figure 1. Distribution of scientific literacy skills in the aspects of knowledge and competence

Knowledge Aspect

The results of data analysis indicated variations in scientific literacy skills in the knowledge aspect. The achievement of scientific literacy ability in the knowledge aspect based on the results of the scientific literacy test per indicator is presented in Figure 2.

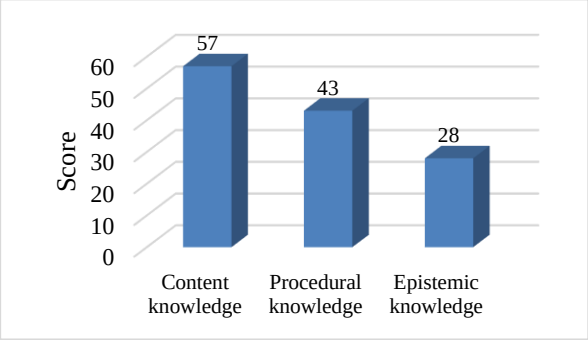


Figure 2. Scientific literacy ability in the aspect of knowledge per indicator

The results of students' scientific literacy ability in the aspect of knowledge showed that the achievement of students' content knowledge was higher than the achievement of students' procedural knowledge and epistemic knowledge. This was supported by the results of previous research which stated that aspects of students' conceptual knowledge were higher than aspects of using scientific knowledge in analyzing texts or articles

(Pantiwati & Husamah, 2014). The achievement of this content knowledge was classified in the medium category which consists of seven questions as presented in Figure 3.

The achievement of scientific literacy ability in content knowledge was reflected by students' ability in providing answers to questions that require students to remember concepts. The average score in this aspect was considered low. However, the questions with the lowest and highest average scores contained significant differences. In question number 3, students were required to explain the concept of starch to glucose transformation in the banana ripening process which produces heat and the effect of temperature. Most of the students were only able to answer the starch to glucose transformation process without explaining the heat generation process and did not give specific answers about the effect of temperature on banana ripening as presented in Figure 4.

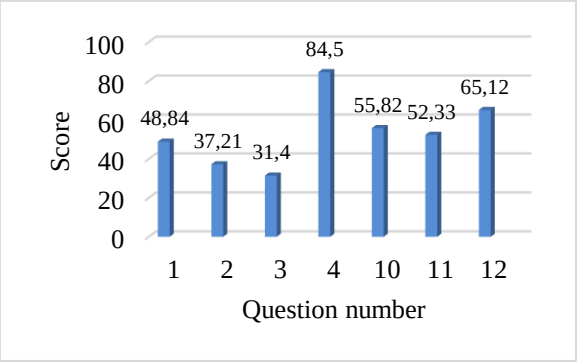


Figure 3. The average score of content knowledge per question

(a)

Tugas 2: Pisang

Pisang dipanen saat masih hijau. Setelah diangkut ke Eropa, pisang hijau tersebut disimpan dalam ruangan khusus untuk pemeraman. Bagian komik berikut menjelaskan apa yang terjadi di dalam ruang pemeraman.

Diadaptasi dari: Chiquita

Dengan menggabungkan dua informasi dari komik tersebut, dapat disimpulkan bahwa udara dalam ruang pematangan harus dibuat rendah untuk mencapai pematangan yang ideal.

Jelaskan dua informasi tersebut.

(b)

informasi pertama yaitu tentang saat pisang matang ia menghasilkan panas karena disebabkan oleh perubahan pati dalam pisang berubah menjadi glukosa. informasi kedua yaitu tentang temperatur ruang pematangan harus terus diawasi agar pematangan ideal, untuk pematangan lebih terkendali bisa menambahkan gas etena di ruang pematangan hingga konsentrasi 0,1%.
Ketika udara dalam rungan rendah makan akan terjadi penguapan pada buah sehingga mempercepat proses kematangan dimana suhu menjadi panas
Karena jika udara terlalu panas pisang akan membusuk, dengan penambahan gas etana pematangan pisang akan lebih cepat dan terkendali

Figure 4. Discourse and questions (a) and examples of answers to question (b) number 3

In previous research with the same instrument, almost all students obtained a maximum score(Witte & Beers, 2003). Furthermore, question number 4 also had the highest average score. In question number 4, students were required to form an equation for the hydrolysis reaction to transform starch into glucose. Most of the students could write the equation for the hydrolysis reaction on the starch to glucose transformation. However, some students were not capable of writing reaction equations correctly, as presented in Figure 5. Having regards to the results of students' answers to questions number 3 and 4, students' memorization ability was considered to be higher than their ability to apply concepts. This result is relevant to the statement which emphasizes that most students are only able to memorize concepts but are less able to relate what they have learned to its application in new situations (Depdiknas, 2003) and the results of research conducted by PISA in 2000 and 2003 which showed that the literacy ability of Indonesian students were only encountered in the ability to remember science knowledge based on simple facts (Rustaman, 2003).

(a)

Berkaitan dengan perubahan pati, seperti yang dijelaskan pada gambar 2 merupakan reaksi hidrolisis.

Berikan persamaan reaksi dari perubahan tersebut. Gunakan rumus molekul; rumus molekul pati adalah $(C_6H_{10}O_5)_n$.

(b)

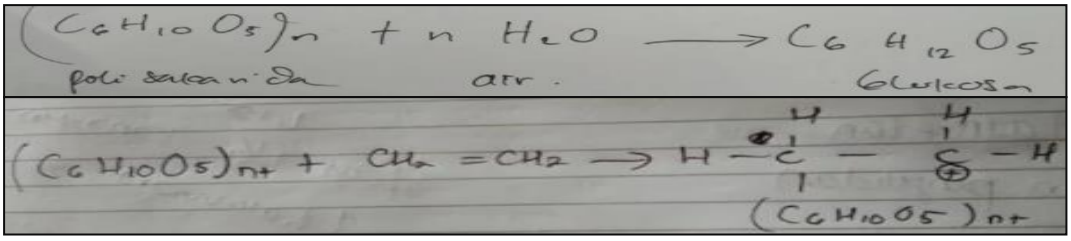


Figure 5. Discourse and questions (a) and examples of answers to question (b) number 4

The achievement of students' procedural knowledge in answering questions was classified in the low category. Students' procedural knowledge ability was considered to be relatively low compared to content knowledge. This is in line with the results of previous research which indicated that the high ability of procedural knowledge was generated by high content knowledge (Rusli Zakaria & Rosdiana, 2018). Therefore, the lack of students' content knowledge may lead to an influence on students' procedural knowledge. The number of knowledge questions consisted of four questions with the average score of each question as presented in Figure 6. The overall average score in this aspect was classified as low and the achievements with significant differences had been significantly encountered.

The lowest average score was found in question number 7, while the highest average score was found in question number 6. In question number 6, students were required to balance the reaction equation and write the electrons in the right position. Referring to the results, most of the students were capable of writing the reaction equation correctly. However, some students were still not able to put the electrons in the right place and do not even involve electrons in the reaction equation, as shown in Figure 7.

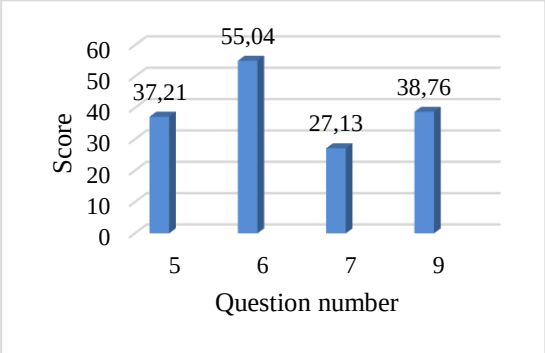
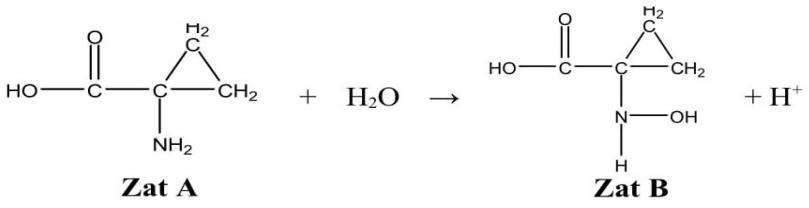


Figure 6. The average score of procedural knowledge per question

(a)

Pembentukan etena melalui pematangan pisang terjadi dalam dua tahap. Selama tahap pertama, zat A bereaksi dengan sebuah agen pengoksida. Zat B merupakan salah satu zat yang terbentuk dalam reaksi redoks ini. Persamaan setengah reaksi dari zat pereduksi disajikan secara tidak lengkap :



Zat A **Zat B**

Hanya electron (e^-) dan koefisien yang hilang dalam persamaan ini.

Salin persamaan yang tidak lengkap ini, dan letakkan e^- di tempat yang benar dan tambahkan koefisien.

(b)

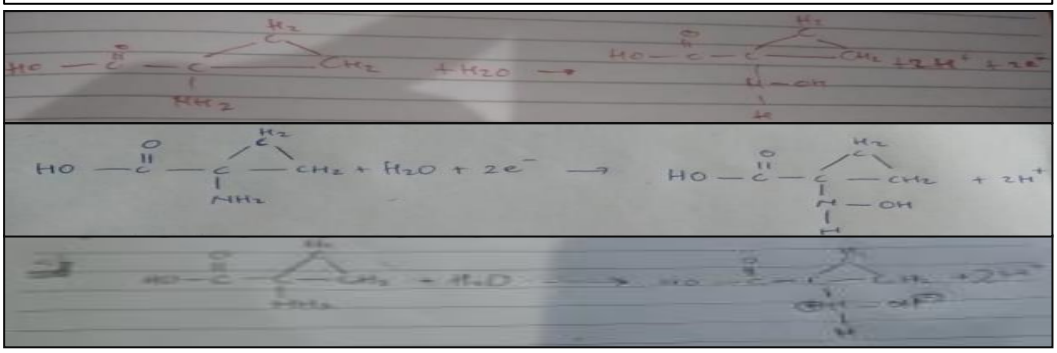


Figure 7. Discourse and questions (a) and examples of answers to question (b) number 6

In question number 7, students were able to write the reaction equation between the redox reaction product and water with a 1:1 molar ratio to produce ethene, methanoic acid, carbon dioxide, and other substances formed, particularly ammonia. Having regards to the result, most of the students were not capable of writing the reaction equation correctly and were not able to correctly determine the other substances formed. However, some students were able to answer the questions correctly, as presented in Figure 8. Regarding to the results of the interview, some students specifically experienced difficulties in solving on the equation of reaction. This shows that students were still not

able to apply their mastered content knowledge regarding to reaction equations in answering procedural knowledge questions. These results are relevant to previous research which indicated that the distribution of scores obtained by students was very varied (Witte & Beers, 2003).

(a)

Pada tahap kedua, zat B bereaksi dengan air dengan perbandingan molar 1:1, yang juga terdapat dalam pisang. Etena, asam metanoat, karbon dioksida, dan zat lain terbentuk pada reaksi ini.

Jelaskan bagaimana rumus molekuler dari zat lain dalam proses ini. Dalam penjelasanmu, gunakan rumus molekuler zat yang terlibat dalam tahap kedua.

(b)

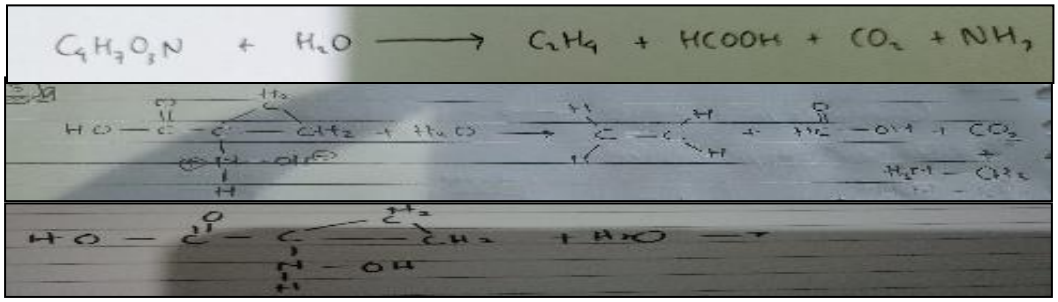


Figure 8. Discourse and questions (a) and examples of answers to question (b) number 7

The achievement of epistemic knowledge was the lowest compared to content knowledge and procedural knowledge in the aspect of knowledge. Epistemic knowledge of students was classified into the low category. The epistemic knowledge question consisted of five questions with the average score of each question presented in Figure 9.

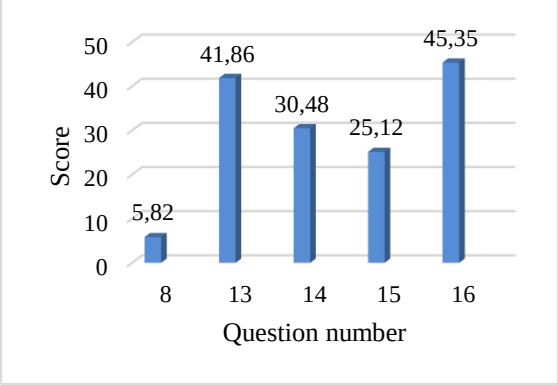


Figure 9. The average score of epistemic knowledge per question

The lowest average score was found in question number 8. Question number 8 described the situation experienced by fruit shop keepers to slow down the ripening process of fruit due to the formation of ethene gas. In this question, students were expected to be able to provide an explanation regarding to the actions that must be taken to overcome these problems. However, based on the results of the answers, students were still not able to provide solutions to overcome these problems, as presented in Figure 10. This indicates that the ability of students to take action according to the conditions described in the comics was still classified as low. These results are in concurrent with the results of previous research, which stated that the lowest achievement was found in

question number 8, where most of the students were not able to provide correct answers related to the questions given (Witte & Beers, 2003).

(a)

Saat pisang hampir kuning, pisang tersebut dibawa ke toko. Pemilik toko harus memastikan bahwa pematangan lebih lanjut berlangsung selambat mungkin; jika tidak, pisang akan menjadi coklat. Salah satu tindakan yang bisa dilakukan adalah menjaga suhu tetap rendah, misalnya dengan menyimpan pisang di ruangan yang bersuhu rendah. Dengan melakukan tindakan lain, pemilik toko dapat memastikan bahwa konsentrasi etena di sekitar pisang tetap serendah mungkin.

Berikan penjelasan mengenai tindakan pemilik toko tersebut

(b)

Dimasukkan kedalam kulkas dan dibungkus pangkal buahnya, agar tidak mengeluarkan gas etena yang menyebabkan pisang cepat matang

Selain itu membiarkan pisang berada di ruang terbuka dan suhu tetap rendah

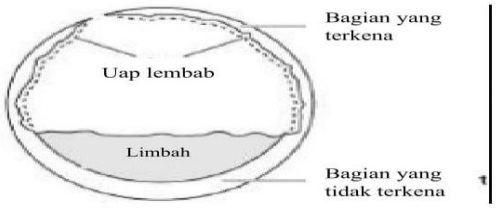
Cara lain selain menyimpan pisang dalam tempat yang bersuhu rendah seperti kulkas ialah dengan cara pisang tidak digabung dengan buah yang lain serta dapat membungkus batang pisang dengan plastik. Alasan pisang ditempatkan pada penyimpanan yang bersuhu rendah ialah agar pelepasan gas etilen dalam pisang dapat berjalan lebih lambat sehingga penyimpanan dapat lebih lama

Figure 10. Discourse and questions (a) and examples of answers to question (b) number 8

Other results were also found in the students' answers to question number 13, where students were required to explain the pipe damage that occurred due to the acidity level. In this matter, most students tended to be unable to provide an explanation of pipe damage due to the acidity of the pipe section, as shown in Figure 11. This shows that students' understandings of the effect of acidity level and students' ability to justify knowledge to produce new knowledge were still considered inadequate (OECD, 2017). Conversely, previous research showed significantly different results, where most students were able to provide an explanation of the effect of acidity level on pipe damage (Witte & Beers, 2003).

(a)

Reaksi larutan asam dengan beton menyebabkan banyak kerusakan. Berikut ini gambar yang mencerminkan keadaan pipa saluran pembuangan setelah beberapa tahun.



Diasumsikan bahwa pH uap lembab di bagian atas pipa lebih rendah dari pH limbah.

Jelaskan berdasarkan kerusakan pipa, bahwa ini merupakan asumsi yang masuk akal.

(b)

Pipa mengalami kerusakan pada bagian atas karena pH uap lembab lebih rendah yang artinya lebih bersifat asam ini disebabkan oleh terlepasnya gas hidrogen sulfida dari limbah (larutan asam) kemudian bereaksi dengan udara dan oksigen sehingga menghasilkan asam sulfat yang sifatnya sangat asam
hal ini karena ph di bagian atas lebih rendah dari pada limbahnya
krn ph tinggi menyebabkan kerusakan pipa

Figure11. Discourse and questions (a) and examples of answers to question (b) number 13

Competence Aspect

The competence aspect had a lower percentage compared to the knowledge aspect. This is supported by the results of previous research which stated that integrated science learning in schools was more focused on concepts and was less integrated on student competencies (Aryani et al., 2016). Other supporting research stated that the memorization ability of students in Indonesia was higher than the ability to apply the knowledge they had acquired (Pantiwati & Husamah, 2014) The percentage of scientific literacy ability achievement in the aspect of competence is presented in Figure 12.

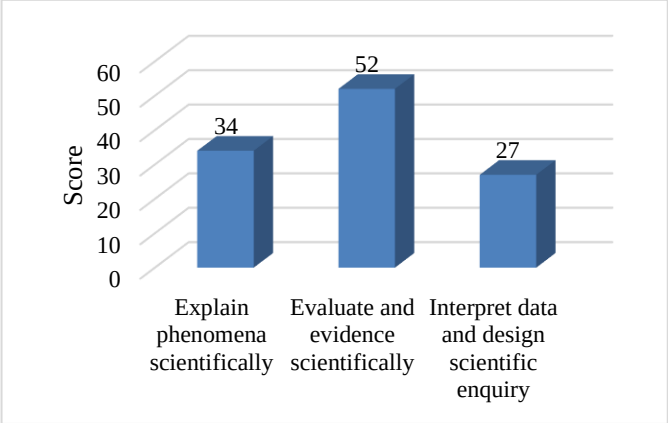


Figure 12. Scientific literacy ability in the aspect of competence per indicator

The achievement of scientific literacy in the aspect of competence in explain phenomena scientifically was classified into the low category. The question of competence to explain phenomena scientifically consisted of 5 questions with the average score of each question presented in Figure 13.

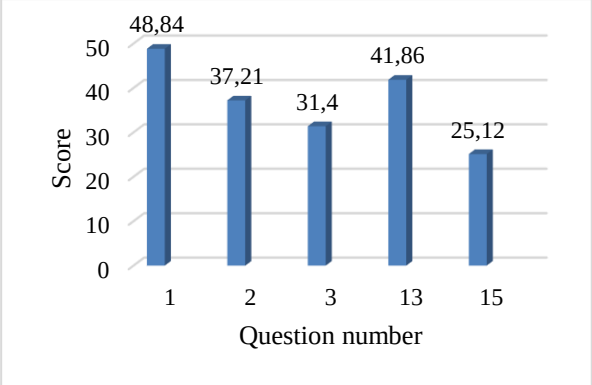


Figure 13. The average score of competence to explain scientific phenomena per question

The average score of competence to to explain scientific phenomena was classified as low and there were found some gaps in scores on questions number 1 and number 15. In question number 1, students were required to explain the concept of separating mixtures of coffee and tea water by means of water containing sand. Having regards to the results, most of the students already had proficiency with the concept of mixed separation on this matter but were not able to give a complete explanation. Furthermore, students' answers were stating that sand in water interferes with the process of making coffee and tea, as presented in Figure 14. This indicates that students were only able to recall simple concepts without being able to provide a scientific explanation of the separation process. This is relevant to the research conducted by Rustaman (2003) which revealed that Indonesian students were considered to be able to remember simple concepts only.

(a)

Tugas 1: Kekurangan air

Mieke dan Rob melakukan perjalanan mendaki selama beberapa hari. Mereka memutuskan untuk berkemah di hutan, tapi mereka mempunyai masalah. Tidak ada air di hutan dan mereka hanya membawa satu liter air di pelples (termos kecil portable).

Mereka telah membeli selada untuk makan malam. Selada tersebut harus dicuci karena berpasir. Mereka menyimpan air yang mereka gunakan untuk mencuci selada di ceret. Keesokan paginya mereka ingin membuat minuman untuk sarapan dengan menggunakan air berpasir tersebut.

Mieke dan Rob dapat membuat kopi atau teh dengan menggunakan air tersebut tanpa ada pasir di dalamnya. Berikut ini cara menyiapkan air kopi atau teh dengan menggunakan air tersebut.

Membuat kopi Membuat teh

Berdasarkan cerita di atas, jawablah pertanyaan berikut ini.

Apakah pasir dalam air tidak mengganggu pembuatan kopi atau teh? Jelaskan jawabanmu.

(b)

Tidak mengganggu, karna pasir akan mengendap di dasar wadah dan partikel pasir tidak bisa menembus saringan
Tidak, dikarenakan sudah dilakukan nya proses pemisahan pasir dari air nya
Tidak, karena pasir akan menjadi komponennya sendiri tidak larut dalam kopi
Mengganggu, karena pasir merupakan partikel yang sukar larut dalam air
Mengganggu, karena pasir merupakan partikel yang sukar larut dalam air

Figure 14. Discourse and questions (a) and examples of answers to question (b) number 1

The lowest average score was found in question number 15. On that question, students were expected to correct the text from the newspaper section about adding calcium nitrate to sewage. Students were required to provide an explanation that the waste water produced does not contain hydrogen sulfide; hydrogen sulfide is formed in the absence of oxygen; sewage pipes containing oxygen can react with hydrogen sulfide to form sulfuric acid; and sulfuric acid formed will contribute to concrete damage. Based on the distribution of the answer scores, most of the students were only able to explain that waste water that did not contain hydrogen sulfide and sulfuric acid could damage the concrete, and some students only rewrote parts of the text without providing improvements to the contents of the text, as presented in Figure 15. This shows that the ability of students in analyzing the text of the newspaper was still relatively low. This research is in line with the results of research conducted by Pantiwati & Husamah (2014) on 90 students of grade VII from three SMP/MTs in Malang City. The results of this research stated that the students' inability to analyze texts or articles indicated that students' thinking ability still tended to be low.

Air limbah yang kita hasilkan tidak mengandung hidrogen sulfida,kemudian bertemu dengan oksigen sehingga dapat membentuk asam sulfat. Setelah itu asam sulfat yg bersifat asam akan menggorogoti beton, yg biasa disebut korosi
Air limbah yang kita hasilkan tidak mengandung hidrogen sulfida karena sudah berubah menjadi asam sulfat. Asam sulfat adalah bahan pengikis yang menggerogoti beton

Figure 15. Students' answers to question number 15

In general, the achievement of competence in evaluate and designing scientific enquiry was classified into the low category with a total of 3 questions with an average score presented in Figure 16.

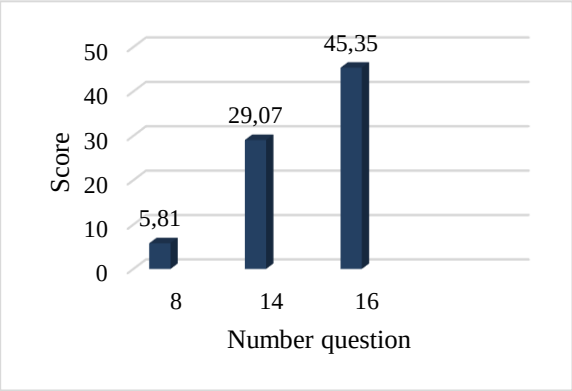


Figure 16. The average score of competence to evaluate and design scientific investigations per question

The highest average score was found in question number 16 and this average score was included to the low category. In question number 16, students were required to explain the action and provide reasons for adding calcium nitrate to the sewer. In regards to the result, most of the students were unable to provide reasons for the action (addition of calcium nitrate), because nitrate was able to prevent the formation of hydrogen sulfide as shown in Figure 17. In the previous research, most of the students were found to be

able to submit the reasons for the action taken. This shows that the ability of students to decide on certain parts of a real action process was still considered low (Witte & Beers, 2003).

(a)

Diharapkan bahwa penambahan kalsium nitrat akan mencegah kerusakan pada sistem saluran pembuangan limbah.

Haruskah kalsium nitrat ditambahkan pada limbah dalam tempat pemompaan, di saluran pembuangan atau di penampungan limbah? Jelaskan jawaban Anda.

(b)

Penambahan kalsium nitrat dalam air berpengaruh terhadap saluran pembuangan air
Harus, dikarenakan untuk mencegah terbentuknya hidrogen sulfida. Kalsium nitrat ini akan menjadi oksidan sehingga tidak terjadi kerusakan pada pipa.

Figure 17. Discourse and questions (a) and examples of answers to question (b) number 16

The achievement of scientific literacy ability in the highest competency aspect in the indicator of interpret scientific data and evidence scientifically is presented in Figure 18. The achievement of scientific literacy ability in the indicator of interpret data and evidence scientifically is reflected in the ability of students to change data from one representation to another on the test instrument used. in this research (OECD, 2015). The indicator of interpreting scientific data and evidence scientifically is included in the low category with a total of eight questions as presented in Figure 18.

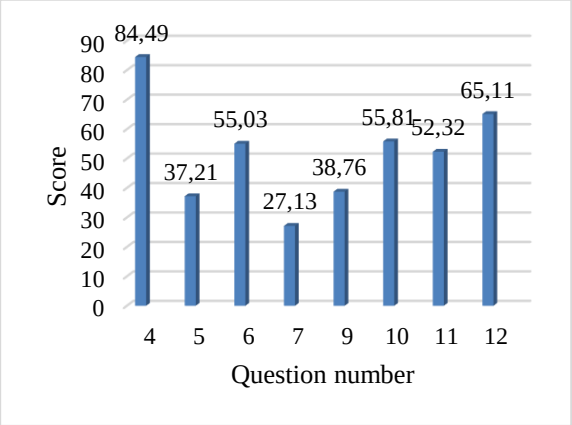


Figure 18. The average score of the competence to interpret scientific data and evidence scientifically per question

The achievement of competence in interpreting data and scientific evidence scientifically was considered relatively low, but the question with the highest average score was found in this aspect, specifically in question number 4. In question number 4, students were required to change data from one representation to another. Referring to the result, most of the students were able to convert the data given into other representations accurately, particularly by writing chemical equations in the form of structures from the names of certain compounds, but some other students were only able to write the structures of certain compounds without being capable of forming reaction equations as presented in Figure 19. The results obtained in this research are higher than the results of previous research (Witte & Beers, 2003). This shows that the students'

ability was classified as high in using knowledge to change data from one representation to another.

(a) Berkaitan dengan perubahan pati, seperti yang dijelaskan pada gambar 2 merupakan reaksi hidrolisis.

Berikan persamaan reaksi dari perubahan tersebut. Gunakan rumus molekul; rumus molekul pati adalah $(C_6H_{10}O_5)_n$.

(b)

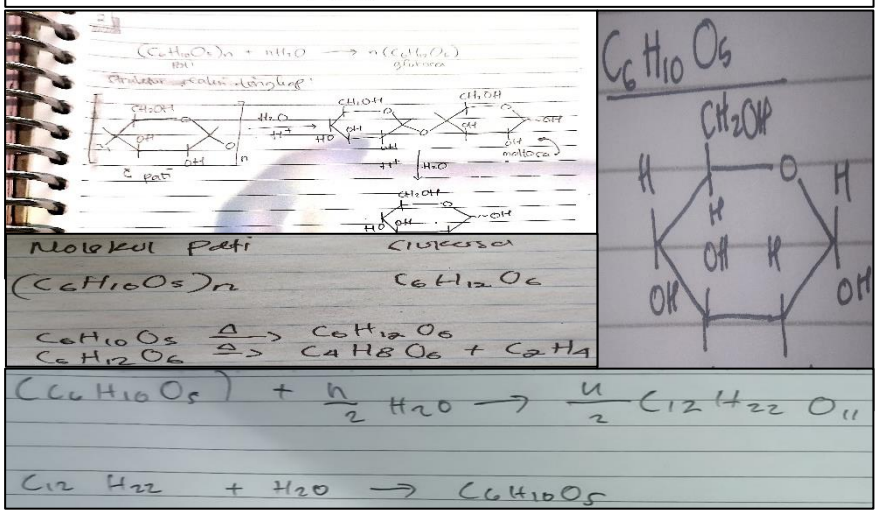
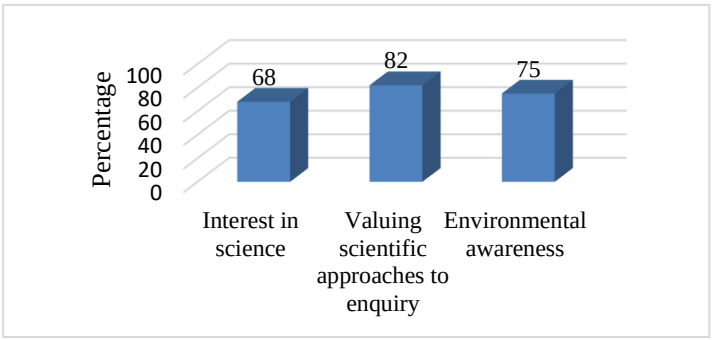


Figure 19. Discourse and questions (a) and examples of answers to question (b) number 4

Attitude Aspect

Attitude aspect is defined as one of the crucial aspects that affect scientific literacy ability in addition to aspects of knowledge and competence. One of the objectives of science education is to develop interest in scientific issues which then acquire and apply knowledge of science and technology for personal, social, and global advantages (OECD, 2006). One of the factors that influence the results of scientific literacy research is the aspect of scientific attitude which includes interest in learning science (Lin et al., 2014).

The achievement of scientific literacy in the attitude aspect was classified into the medium category. The percentage of achievement of the attitude aspect of scientific literacy in each indicator and the percentage of each statement are presented in Figure 20 and Figure 21.



Gambar 20. Scientific literacy ability in the aspect of attitude per indicator

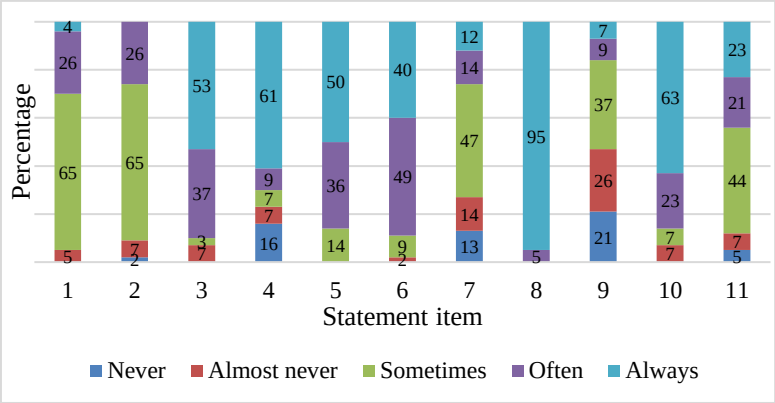


Figure 21. Percentage of each statement item

Students' interest in science was classified into the medium category. This could be seen in students' interest in learning science by revisiting lecture materials at home and utilizing information technology and social media in following the development of scientific and information issues that are developing in society with the statements presented in Table 9. Interest in science indicates individual passions for science, such as an interest in studying science (Iksan et al., 2006).

Table 9. Statements of interest in science

No	Statement
1	I regularly find out facts about science issues that are currently being discussed on social media through scientific articles
2	I routinely recall the lecture material at home to increase my understanding of the material that has been delivered by the lecturer
3	I consistently update with the latest news about covid-19 on television

Valuing scientific approaches to enquiry was classified into the high category. This could be found in students' attitudes in utilizing information from the findings of action, by being careful in receiving new information and using scientific research results to support enquiry with the statements presented in Table 10.

Table 10. Statements about valuing scientific approaches to enquiry

No	Statement
4	I do not use a scuba mask when I leave the house during the pandemic, because I follow the health protocols that have been regulated.
5	I do a careful investigation regarding to the news I receive, whether it is a fact or just an opinion
6	I use scientific articles as reference material for preliminary research

Environmental awareness indicators were classified into the medium category. This could be found in students' awareness in regards to environmental issues and their attitude in preserving the environment. Students had high concern and responsibility towards resources and the environment by not burning waste in the open air, saving energy use, using environmentally friendly products, disposing of waste in its place, and minimizing the use of private vehicles with the statements presented in Table 11. These environmental attitudes demonstrated an interest in science and a motivation to act responsibly towards the environment. This is supported by the results of previous research which stated that

interest in science issues would encourage individuals to solve environmental problems, which was subsequently able to be responsible for the quality of the surrounding environment (Parsaoran & Bukit, 2013).

Table 11. Statements of environmental awareness

No	Statement
7	I clean the household garbage by burning it
8	I turn off the water tap after use
9	I will bring my own shopping bags to the market to reduce the use of plastic bags
10	I throw the garbage in its place
11	I will walk or cycle to nearby places

The results of the analysis obtained can be used as a reference for the development of students' scientific literacy skills that can be done through the integration of scientific literacy in the learning process and in the use of the learning media. Efforts to improve students' scientific literacy ability can be done in several ways, including applying ethno science-based learning, structuring the scope of material and lecture processes, as well as learning tools using the Science Technology Society (STS) model (Irmita, 2018; Pertiwi & Rusyda Firdausi, 2019; Rini et al., 2021).

▪ CONCLUSION

Regarding to the results and discussion, the scientific literacy ability of the Chemistry Education students at Tanjungpura University can be summarized in three aspects, specifically: 1) The aspect of knowledge was classified into the low category with an average score of 43, including the score of content knowledge which was amounted to 57 (medium), procedural knowledge of 43 (low), and epistemic knowledge of 28 (low). 2) The aspect of competence was classified into the low category with an average score of 38, including the score of on the ability to explain scientific phenomena of 34 (low), to evaluate and design scientific enquiry of 52 (low), and interpret data and evidence scientifically of 27 (low). 3) The aspect of attitude was classified into the medium category with an average percentage of achievement by 75%, including indicators of interest in science at 68% (medium), valuing scientific approaches to enquiry by 82% (high), and environmental awareness by 75% (low). Further research is highly required to improve students' scientific literacy skills. The results of the analysis obtained can be used as a reference for the development of students' scientific literacy skills that can be done through the integration of scientific literacy in the learning process and in the use of the learning media. Efforts to improve students' scientific literacy skills in aspects of knowledge and competence may be applied through the integration of scientific literacy in the learning process and learning media, such as applying ethno science-based learning and utilizing the Science Technology Society (STS) model of learning (Irmita, 2018; Pertiwi & Rusyda Firdausi, 2019).

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