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Profile of Student's Scientific Literacy in Immune System Materials Through Problem Based Learning (PBL)

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Abstract

This study aims to analyze profile of students' scientific literacy in immune system material seen by aspects of competence (science process), content (knowledge), and context (application) through problem-based learning (PBL). This study used an experimental method, namely one shot case study design. The population used in this study is class XI SMAN 1 Palimanan with a research sample of class XI MIPA 1,2,3,6 amount of 134 students. Instrument used a reasoning multiple choice test sheet to measure students' scientific literacy profiles and interview sheet to add data the results of the scientific literacy test. Sub-material used the concept of immune system material and its application. The results showed that contained on 4 students (2.99%) in very high category of scientific literacy, 22 students in high category (16.42%), 63 students in medium category (47.01%), 18 students in low category (13.44%) and 27 students in very low category (20.14%). Indicators explaining scientific phenomena can be achieved well with the number of students 45 and the proportion of achievement is 33.58%; scientific scientific survey can be achieved well with the number of students 53 and the proportion of achievement is 39.55% .; interpret data and scientific evidence well with the number of students 49 and the proportion of achievement is 36.57%. Based on the results of the study, it can be concluded that students' scientific literacy is in the medium group.

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INTRODUCTION

The 21st century is a globalization and human life has changed. The changes that occur include the development of industrial world and the availability of information that can be accessed anytime and anywhere. Development of the industrial world will have a positive impact, if it is developed wisely, nevertheless this development will cause problems if it is overused. The government has made efforts to minimize all forms of problems arising from industrial development, one of them is through education.

In education world, students are taught to understand their environment and world through science. Science aims to form patterns of thought and behavior that can shape the character of caring and being responsible for himself, society and the world. The presence of science that shapes mindset, behavior and characters for the universe can be defined as scientific literacy (Kemendikbud, 2017).

Scientific literacy is a skill for living in the 21st century and becomes the foundation of scientific knowledge in everyday life (Gultepe and Killic, 2015). Scientific literacy is also an aspect of the Program for international student assessment (PISA) which was initiated by the Organization for Economic Cooperation and Development (OECD) to evaluate the education system in various countries. Based on the results of the PISA survey, it shows that the scientific literacy of Indonesian students is still low. In 2015, Indonesia was on 62nd from 72nd countries surveyed. The science competency score is 403 below the OECD average, that is 493 (Kemendikbud, 2016). In 2018, Indonesia was on 70th from 78th countries surveyed. The science competency score is 396 below the OECD average, that is 489 (OECD, 2019). The low level of scientific literacy based on the PISA results is the basis for the government to continue to strive to improve scientific literacy. The government's efforts to develop scientific literacy become a basis for teachers to train and develop students' scientific literacy in schools. In fact, the application of scientific literacy is rarely done by teachers. Based on the results of observations and interviews with biology teachers at SMAN 1 Palimanan, it was revealed that teachers had not assessed students' scientific literacy yet.

According to Odja and Payu (2015) the main factor that affects students' level of scientific literacy is the habit of solving tests or problems in they life. One learning model that is associated with problems in everyday life is problem based learning (PBL). Problem based learning (PBL) is learning that begins with giving problems regarding daily life followed by finding solutions by students to solve these problems. The assessment of scientific literacy skills in the PBL model has been widely used. Based on research by Rizki et al. (2013) PBL can improve students' scientific literacy skills. Research by Imansari et al., (2018) that students' literacy skills can be trained through the PBL model and competency aspects are in the low category. Sari and Haryani's (2015) research shows that students' scientific literacy skills in redox material increased after the application of the problem based learning (PBL) model.

Based on the description above, it can be seen that scientific literacy is a reference for 21st century learning and a reference for curriculum development in 2013, so it is very important to assess students' scientific literacy. This study aims to analyze the profile of students' scientific literacy in the body defense system material in terms of competence (science process), content (knowledge) and context (application) through problem based learning (PBL).

METHOD

This study used an experimental method, namely one-shot case study design. The population in this study were all students of XI MIPA SMAN 1 Palimanan in second semester of the 2019/2020 academic year with 236 students. The sample of this research is XI MIPA 1,2,3,6 as many as 134 students taken by purposive sampling based on the considerations of the school teachers and all classes in this study applied problem based learning (PBL). This research was conducted online due to the global Covid-19 pandemic. Using several software such as google classroom, WhatsApp, zoom and webex. Google classroom is used in online learning while WhatsApp is used for ease of communication and Webex is used to clarify learning based on discussion results.

Data collection technique used in this study was a test. Instrument used was a reasoned multiple

choice test totaling 40 questions. Instrument analysis techniques include validity, reliability, level of difficulty and differentiation. The instrument was then tested on student of XII class, and the questions used for the study were validity in very good to sufficient category, good reliability, not too high and not too easy of level difficulties, and good distinguish.

Posttest data literacy will be taken after PBL learning was applied. The percentage of scientific literacy scores is determined based on the number of answer scores obtained by students then converted into 0-100 scale. The profile of scientific literacy is obtained by scoring and leveling based on posttest scores so that students with very high, high, medium, low and very low knowledge levels can be obtained. The criteria for the assessment of the scientific literacy group were adjusted to Table 1.

Table 1. Criteria of assessment scientific literacy group

Value	Criteria
86 - 100	Very high
76 - 85	High
60 - 75	Medium
55 - 59	Low
≤ 54	Very low

In addition, the achievement of each indicator of scientific literacy is calculated through the total number of student scores then taking the average student score and interpreting it into the categories listed in Table 2.

Table 2. The Achievement categories of scientific literacy

Interval	Categories
0 – 39	Fail
40 – 55	Deficient
56 – 65	Sufficient
66 – 79	good
80 – 100	Excellent

RESULT AND DISCUSSION

The instrument of scientific literacy questions was tried out (40 questions), which fulfill the criteria is about 30 questions. The items were rejected because of their low validity value, the difficulty level was too high or too easy and the distinguish was not good. The reliability of the test questions above is 0.89, so it can be said that the scientific literacy test questions are reliable.

Thirty question items that received have very valid and valid validity levels, the level of difficulty is not too difficult and not too easy, the distinguishing power is in the good and sufficient category and the reliability is good. Apart from these considerations, the selected questions also consider indicators of scientific literacy. One question used to measure students' scientific literacy consists of content, context and competence. The explanation is as follows 1) the content consists of sub-material explaining the definition and function of the body's defense system, finding organs that play a role in the body's defense system, distinguishing non-specific and specific mechanisms, explaining the terms antigens and antibodies, finding types of immunity, analyzing relationships immunization with immunity against a disease, and analyzing disorders of the body's defense system; 2) context refers to personal, local / national and global cases; And 3) competence refers to explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence.

In question items number 1-4 are about personal context, namely the case of tears (non-specific defense), which item number 1 was rejected because it is too easy. Question items number 8-12 are about the global context, namely the Covid-19 case, question number 12 is rejected because it is too difficult. Question number items 14-17 on the national context, namely the case of breastfeeding, question item number 15 is rejected because it is too easy, many students answered correctly and the choice of answers is not deceptive. Question items number 21-25 are about the national context, namely the case of MR immunization, question items number 21 are rejected because it is too difficult and number 25 is rejected too, it is too easy. In the case of HIV, question items number 30 and 32 are rejected because they are too easy. Question items number 37-40 address the national context, namely hepatitis cases, questions number 39 is rejected because it is too difficult and number 40 rejected because it is too easy.

The questions used represent all indicators of scientific literacy. In the indicators of evaluating and designing scientific investigations, from 11 questions tested, only 3 were rejected. The indicator

explains scientific phenomena, from 17 questions made, only 4 questions were rejected. The indicator interprets the data and scientific evidence, from 12 questions only 3 questions were rejected.

Based on 30 questions tested in class XI SMA, it can be seen that the profile of students' scientific literacy based on the posstest scores after problem based learning (PBL) learning. The data in Table 3 provide an overview of the student's scientific literacy profile in the medium category as many as 63 students (47.01%). Most students can choose the right answer but give wrong reasons or choose the wrong answer but give right reason. The very high group was only 4 students (2.99%), its possible because students are less accustomed to applying material to real life so it requires good analytical skills and understanding of concepts. This is same with the opinion of Hollbrook & Rannikmae (2009) that scientific literacy is related to the application of science and technology concepts to solve problems and make decisions based on the analysis and evaluation of scientific evidence. According to Fang & Wei (2010), the contributing factor to low scientific literacy is that students are less trained to distinguish science and technology facts and student are less give the opinion to new scientific facts.

Table 3. Profile of student's scientific literacy in problem based learning (PBL)

Group of science literacy student	Student	Percentage (%)
Very high	4	2 .99
High	22	16 .42
Medium	63	47 .01
Low	18	13 .44
Very low	27	20 .14

The scientific literacy profile is related to students' understanding when taking data, recognizing the main characteristics of scientific investigation and analyzing and proposing ways to solve a problem. In this study, students were not used to seeing facts in the field or connecting the real cases with material so that when they take on case-based questions, students get the trouble to explain them. According to Yuliati (2017) students should be able to meet the various demands of the times, namely to become problem solvers with individuals who are competitive, innovative, creative, collaborative and they have character.

The difficulty of students in describing and explaining the material is same with the results of Sinaga's research (2015). Basically, students have the ability to identify problems but they have difficulte to connect the appropriate concept of knowledge. Research by Fakhiyah et al., (2017) also proves that the limitations of understanding the material will affect the ability to explain concepts with own opinion. They need to introduce the material to everyday life through learning. This is in line with Tsubokura et al., (2018) that scientific literacy can be trained through learning that put practice first and case studies around them. Learning that puts forward knowledge that is relevant to everyday life will be more effective to increase students' scientific literacy.

The student's scientific literacy profile data indicates three indicators of scientific literacy, namely the student's ability to explain scientific phenomena, evaluate and design scientific investigations, and interpret scientific data and evidence. The achievement of scientific literacy indicators is calculated, the results can be seen in Table 4

Table 4. Data of achievement student's science literacy indicators

Scientific literacy indicators	The achievement of scientific literacy indicators (% student)				
	Excellent	Good	Sufficient	Deficient	Failure
*L1	30 (22 .39)	45 (33 .58)	28 (20 .89)	22 (16 .42)	9 (6 .72)
*L2	17 (12 .69)	53 (39 .55)	29 (21 .64)	22 (16 .42)	13 (9 .70)
*L3	13 (9 .70)	49 (36 .57)	43 (32 .09)	25 (18 .66)	4 (2 .98)

Explanation :
*L1 = explain science phenomena
*L2 = evaluate and design scientific investigations
*L3 = interpret data and scientific evidence

Table 4 shows the greatest achievement of each indicator in the good category, namely 33.58%, 39.55%, and 36.57%. However, on the indicators explaining scientific phenomena as many

as 30 students (22.39%) were achieved very well. The highest percentage of failure in the category of achievement was an indicator of evaluating and designing scientific investigations with 13 students (9.70%).

Indicators explain scientific phenomena related to the ability to remember and apply material knowledge, make and justify correct predictions, and provide clear hypotheses in dealing with issues that can be investigated scientifically. In this study, as many as 45 students (33.58%) were able to explain scientific phenomena in good categories. This percentage shows that students can analyze a case in question and are able to explain the reasons according to immune system material. According to the OECD (2016), scientific literacy is related to the ability to recognize and remember simple scientific concepts, explain and describe a model, propose and predict hypotheses and apply scientific knowledge in everyday life. The results of this study are same with the results of research by Widiana et al., (2020) in class XI at SMAN 1 Lembah Melintang, the highest achievement of scientific literacy in PBL learning, the coordination system material is the aspect of explaining scientific phenomena, as many as 73% of students achieved it well.

Explaining scientific phenomena can train students to understand concepts and explain material contextually and be able to apply them in everyday situations. This is in accordance with the opinion of Wulandari & Sholihin (2016) that the development of scientific literacy can be done by connecting the cognitive aspects of students with scientific phenomena commonly found in everyday life. According to the OECD (2016), scientific literacy can be developed by connecting issues about science, scientific ideas, and their application as reflective citizens.

Indicators explain scientific phenomena to 9 students (6.72%) categorized as fail because students do not understand the material that has been presented, and students are not used to take on with case-based questions. That is reinforced by the results of student interviews in the very low group. The following is a fragment of the transcript interview between the researcher with students who have very low scientific literacy.

P : jadi gimana, air mata apakah benar bukan penghalang spesifik ?
S9 : sepertinya iya bu,
P : kok ragu? kenapa ?
S9 : iya bu maaf, saya kurang begitu paham tentang air mata itu bu kaitan sama materi nya apa
P : kok bisa kurang begitu paham, jawabanmu bener lo ini tetapi tidak ada alasannya
S9 : iya bu, saya tidak tau kelanjutannya gimana

The results of the interview above can be described that S9 students are not used to associating a case with material, so that S9 students cannot give reasons for the answers they have chosen. The case of tears is an indicator taken from a personal context and a sub-material of non-specific defense mechanisms. These students do not understand that tears are still classified as non-specific. This is different from students in the very high group whose scientific literacy skills are able to explain scientific phenomena very well. The following is a fragment of the transcript of the researcher interview with students who have very high scientific literacy.

P : jadi nomor 22 itu apakah benar jawabannya E?
S1 : iya bu menurut saya mah bener, karena termasuk hipersensitivitas dan masih diluar spesifik maksudnya teh masih melibatkan komponen non spesifik bu, yang IgE trus IgE nya merangsang histamin, kurang lebih seperti itu bu.
P : memang proses nya bagaimana kok bisa IgE merangsang histamin?
S1 : IgE teh sudah terbentuk dalam tubuh kan ya bu karena susi sudah pernah terpapar alergen sebelumnya, nah itu teh IgE itu tuh bisa merangsang keluarnya histamin. Terutama dari permukaan sel mast bu kalau tidak salah. Trus teh kalau histaminnya keluar baru terasa alergi nya, kulit memerah dan sebagainya bu.

Students S1 can explain hypersensitivity cases and relate them to examples of everyday life. The explanation is sufficient to represent the answers on the posstest scientific literacy questions, so it can be concluded that the ability to explain scientific phenomena is very good.

The second indicator of scientific literacy, evaluating and designing scientific investigations relates to the ability of students to identify and evaluate cases or issues, distinguish statements that can be investigated scientifically, and propose ways of exploring scientifically. In Table 4, the achievement of the second scientific literacy indicator is classified as good, as many as 53 students (39.55%) are greater than indicators one and three. The competence to evaluate and design scientific investigations requires students to have the ability to identify, explain, evaluate, and apply scientific knowledge and other knowledge to complex daily life. This is same with the opinion of Gormally et al., (2012) that students who have good scientific literacy are easier to analyze and recognize a method in an investigation or case and are easier to organize and interpret information or data into other forms.

The something from students what they need to instruct ability to evaluate and design scientific investigations is to provide questions that are contextual and easy, the text is evident, and the cases are easy to find in their life. According to Hebel et al., (2017), contextual questions can make it easier for students to measure and evaluate each issue or problem, while still considering difficult and easy questions, in other that students who have low scientific literacy can still hypothesize difficult questions.

In evaluating and designing scientific investigations, 13 students (9.70%) were in the failed category. This failure was caused because the students had never worked on scientific literacy questions before and students are less skilled in evaluating the cases presented. Students prefer to memorize learning material rather than understand it, so they have difficulty answering questions that contain indicators of scientific literacy. According to Jamaluddin (2018) the role of the teacher in applying scientific literacy questions to learning is very important to develop students' scientific literacy. The tendency of the teacher to associate real life examples during learning, the science literacy will be better. The low achievement of this indicator shows that this indicator is difficult, so students need more intensive teacher guidance. According to Novili et al., (2016), practicing ways of evaluating experimental results during practicum learning can improve scientific literacy.

The low achievement of indicators of evaluating and designing scientific investigations is reinforced from the results of interviews with the medium and very low groups. The following is a fragment of the interview between the researcher with the middle group students.

P : nomor 24 pernyataan yang benar yang mana ?
S5 : yang A bu
P : coba jelaskan mengapa kalau jawabannya A
S5 : sebentar bu saya ingat-ingat dulu, kalau tidak salah ya bu inflamasi itu hubungannya dengan luka, kalau luka di kulit terus bengkak , seperti itu bu inflamasi. Penyebabnya karena ada jaringan tubuh yang rusak sehingga tubuh mengeluarkan histamin. Bener tidak bu?
P : kenapa malah tanya ibu?
S5 : iya soalnya agak sulit bu

The results of interview can be described that student S5 doubt in answering the questions even though the answer is correct, but student S5 thinks that the questions is difficult. The students in the very low group also felt that the problem was difficult. The following is a fragment of the transcript interview between the researcher with very high scientific literacy students.

P : nomor 24, kenapa kamu tidak memberikan alasannya ?
S10 : saya teh tidak tau bu
P : coba yang kamu tau apa tentang inflamasi ?
S10 : inflamasi teh pokoknya golongannya pembengkakan gitu
P : kamu yakin?
S10 : iya bu saya tau nya teh itu wae

Students' hesitation in answering questions during the interview shows that the indicators of evaluating and designing scientific investigations are indeed difficult. This is also reinforced by the habit of students who rarely work on types of scientific literacy questions, the teacher only measures students' understanding rather than to the analysis. According to Arief (2015), the low ability of students to evaluate and design a scientific investigation is due to learning habits that have not facilitated investigations so that students have difficulty developing these abilities.

The third scientific literacy indicator interprets scientific data and evidence related to the ability to analyze, identify assumptions, evidence and reasoning, analyze and identify a data or case, transform data from one form of representation to another, and draw conclusions. Interpreting data and scientific evidence is the student's ability to analyze data, interpret it and interpret it in everyday life. In Table 4, as many as 49 students (36.57%) achieved the third indicator of scientific literacy in the good category. The percentage of achievement is not that big from the literacy indicator 2. This is because students only see the discourse that has been presented but does not relate to existing material. This was confirmed by the results of interviews with low-level students. The following is a fragment of the transcript interview between the researcher with students who have low scientific literacy.

P	: nomor 8 mana yang termasuk antigen?
S7	: D bu
P	: kamu yakin jawabannya D?
S7	: iya bu yakin, itu jawabannya ada di teks bu. Yang golongan covid saya lupa beneran bu

The results of the interview above show that the students answered questions confidently because they saw the text that had been presented, they did not associate the material that the antigen was a substance / molecule. There are several things that affect the students' lack of interpreting data and scientific evidence, namely student not understanding the material presented, not reading carefully, and spending a lot of time on the rote aspect. This is in line with the opinion of Safitri & Mayasari (2018) that students' lack of ability to interpret data and scientific evidence is students do not understand several terms in investigative activities, rarely do practicum and read things/issues that are happening.

The application of the problem-based learning (PBL) model in this study is effective for training students' scientific literacy, although that is not perfect. Same with the research of Setiani et al., (2016) that the problem-based learning model is effective in training students' scientific literacy. Furthermore, according to Yuliati (2017), scientific literacy skills can be developed by implementing learning materials and problems experienced by students. The development of scientific literacy includes students' knowledge and understanding of science, not only knowing the concepts of science but also applying them in solving life problems. Learning that focuses on the achievement of scientific literacy is learning that is process and result oriented, not just emphasizing the memorization of knowledge.

In this study, PBL learning was carried out online, using the webex application. Online learning can be combined with problem based learning (PBL). This is in accordance with the research of Ibrahim et al., (2017) that online learning can increase participation and cooperation between students if its implementation puts forward some issues or problems of daily life. Furthermore, according to Chen et al., (2018), combining online learning and problem based learning (PBL) can train students to interact online and develop reading skills while doing school assignments.

CONCLUSION

The results showed that contained on 4 students (2.99%) in very high category of scientific literacy, 22 students in high category (16.42%), 63 students in medium category (47.01%), 18 students in low category (13.44%) and 27 students in very low category (20.14%). Indicators explaining scientific phenomena can be achieved well with the number of students 45 and the proportion of achievement is 33.58%; scientific survey can be achieved well with the number of students 53 and the proportion of achievement is 39.55%; interpret data and scientific evidence well with the number of

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