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Profile of Senior High School Students on Scientific Literacy Skills

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Abstract. Education is currently faced with the demands of the 21st century, one such demand that students must have the skills of scientific literacy. This study aim to describe the profile of students' scientific literacy skills in acid base topic. The subjects of this study were high school students consisting of 15 random selected students. Instruments used in this study are test sheet and questionnaire. The test consists of four questions that contain aspects of context, ability, and knowledge in scientific literacy. The questionnaires consist of thirty positive and negative questions that contain the aspect of scientific literacy attitude. The data result of the research result is analyzed using descriptive, quantitative and qualitative methods. The scientific literacy skills in this study refers to PISA 2015 which includes four aspects, namely context, ability, knowledge, and attitude. The results showed that the skills of scientific literacy has low category on the aspect of context, ability, and knowledge including low category, while the attitude aspect is low category. This results indicate profile students' of the scientific literacy skills. These findings will serve as a basis for further research on innovative learning models and strategies that can improve scientific literacy skills of students.

Keywords. scientific literacy skills, acid base topic

INTRODUCTION

The 21st century is a century of knowledge that is widely disseminated information and emerging technologies, a number of such challenges must be faced by students and teachers in order to survive in the century of knowledge in the information era mainly in the learning process, especially chemistry. Learning activity in Indonesia currently has used the 2013 curriculum. Learning of the 2013 curriculum learning uses a scientific approach or a scientific-based approach that includes observing, questioning, collecting information, experimenting, reasoning or associating, and communicating [1]. Understanding chemistry is very critical, because our physical environment is heavily affected by chemistry and filled with chemical products [2]. Chemical learning should enable students to experiment, including formulating problems, filing and testing hypotheses, defining variables, designing and assembling instruments, collecting, processing and interpreting data, drawing conclusions, and communicating experimental results verbally and literally. One of the chemical matter is acid base. The topic of acid-base is a solid material and requires an understanding that is integrated into many chemical introduction concepts such as particle characteristics in matter, the properties and composition of solutions, atomic structures, ionic and covalent bonds, symbols, formulas and reaction equations, ionization and equilibrium [3].

Scientific literacy is the ability of a person to use scientific ability, understand and apply (oral and written) science knowledge to solve problems until having high attitudes and sensitivity to themselves and the environment, participate actively and intelligently handle science-based problems in society and make decisions based on consideration of science [4]. Scientific literacy is also defined as the capacity to use scientific knowledge, identify

questions and write conclusion based fact and data to understand the universe and make decisions of changes that occur due to human activity [5]. Scientific literacy as wider science disciplines especially relating with science application in daily life [6]. Scientific literacy allows the public to live effectively in a very rapidly changing natural world [7].

Scientific literacy is more focused to understand science by means of scientific method, so that students can not only connect between problems with science as a concept but also between issues related to things other than in life. Scientific literacy of prioritizes the ability of a more contextual science process with a variety of general content that may appear in everyday life [8]. Scientific literacy becomes a must for every person. Scientific literacy becomes very important for person because the reverse of a nation, one of them, is determined by the quality of human power that has the literacy to science and technology [9]. Scientific literacy according to PISA 2015 includes four aspects, namely: context, competencies, knowledge, and attitude.

The skills of scientific literacy is very important to be applied to the learning activity, because in learning chemistry especially, needed the meaningful learning. The optimal level of meaningful in science learning for students can be obtained if the students have good scientific literacy skills [10]. The development of scientific literacy is very important because it can contribute to social and economic life and improve decision making at the community and personal level [11]. Other life skills are needed to confront the era of globalization, namely the skills of scientific literacy [8]. Scientific literacy is the basis of science education [12]. This means, it is necessary to know the skills of scientific literacy in the students, which later on the students' literacy skills can also be used as a basis for further action to prepare them in facing the next challenge.

Scientific literacy skills is indispensable for dealing with 21st century problems that are needed in the contextual problem solving. The fate of the people requires the skills of the literacy. But before the scientific literacy skills of the organization, the researcher must know the student's initial skills. The results from the study of the scientific literacy capability profile can be used by researchers who will develop a device to overcome the problem. At this time, scientific literacy skills are studied in chemistry learning. This is because, chemistry is an experimental discipline, chemists conduct scientific inquiries, make generalizations and suggest theories to explain the natural world, chemistry provides knowledge used to explain phenomena in other areas, such as earth sciences and life sciences [13].

Based on the above explanation, the researcher will make a research with research question "How is the profile of students science literacy skills in SMA Muhammadiyah 10 Surabaya on acid base topic?". This study aims to describe the profile of students' scientific literacy skills in SMA Muhammadiyah 10 Surabaya on acid base topic.

METHODS

This research is a descriptive research that aims to determine the early skills of scientific literacy students about chemistry lessons, especially acid-base topic. Sample in this study were students of class XI MIA I SMA Muhammadiyah 10 Surabaya as many as 15 students selected at random. Instruments used are test sheets and questionnaires. The questions on the test sheet include 3 aspects of literacy, namely aspects of context, knowledge, competence, while for the questionnaire includes aspects of attitude. Data collection techniques using test and questionnaire techniques. Data analysis technique is done by calculating the result of questionnaire and the skills of science literacy that has been done by sample.

RESULTS AND DISCUSSION

In this research, aspects of context, knowledge and competence are obtained from the test sheet in the form of essays. The test sheet had been given to the students in the form of 4 essay questions that contain about the description of the reading that must be analyzed by students with the skills of scientific literacy. The test in the form of essay is used because it has the advantage of being able to assess the students' ability to analyzing and synthesizing a problem, the students cannot guess and it is suitable for measuring complex learning outcomes [14]. Problem given is about acid base material with sub matter development of acid-base concept, acid-base indicator

and acid-base pH. One of scientific literacy core is the ability to identify problems. Therefore to improve the achievement of student's scientific literacy should be faced with the problems of daily life [6]. The test results data of these three aspects are changed in percentage form, which can be seen in Table 1.

Table 1. Test results data for aspects of context, knowledge, and competence

Question number	True	False
1	53,3%	46,7%
2	33,3%	66,7%
3	40,0%	60,0%
4	40,0%	60,0%

The question on the test sheet is described as follows:

Question number 1 reads about the development of acid-base theory by Arrhenius, Bronsted Lowry, Lewis. Further describes the results of J. N Bronsted experiments in Denmark, and T.M Lowry, G. N. Lewis by displaying representative illustrations and their reaction equations. Lewis explained the basis of the grouping of acids and bases.

Based on the question, students are asked to define some compounds, namely H_2O, NH_3, BF_3, whether the compound is acid or base, and gives the reason based on acid-base theory (Arrhenius, Bronsted Lowry, and Lewis). Question number 1 is a matter that contains aspects of context, competence (interpreting data and scientific evidence), and knowledge (content). In this case as many as 53,3% of students can answer correctly. This is possible because most students have understood the theory of acid-base. The correct answer is that H_2O is an acid because it acts as a proton donor, NH_3 is a base because it acts as a proton receiver, BF_3 is an acid because it can accept pairs of electrons from other particles to form covalent coordination bonds. Based on student answers, they can classify the compounds correctly, but the reasons given are wrong.

Question number 2 contains a reading about the antacid stomach drug. There is an understanding of the antacids, the compositions of the antacids and their explanations, the reaction equations that occur when the antacid composition reacts with HCl, and there is also a working process of the antacid.

Based on the reading the students were given a question to find out how the process of antacid work in overcoming the heartburn and classify the nature of acids and bases based on the compounds contained in the reading. This issue contains aspects of context, competence (explaining the phenomenon scientifically), and knowledge (content and epistemic). Overall, only 33,3% of students were able to answer correctly. The correct answer is "antacids contain an aluminum compound which is a colloidal substance. This compound will coat the mucous membrane which will neutralize the HCl present in the stomach fluid and bind the HCl in an adsorptive manner". Most of the students' answers are "Antacids will directly neutralize acidity, increase pH, or reversibly reduce or prevent gastric acid secretion by cells to reduce acidity in the stomach", can be interpreted that the student's written answer is a function of antacids, not the workings from antacids. In this question most students answer the wrong possibility because students do not read the reading until finished and not used to work on the question with the characteristics of the matter that many readings.

Question number 3 contains a table containing experimental data from some solution and color change indicator after the solution is dropped. There are natural indicator of hibiscus rosa-sinensis and turmeric which is dropped with solution of A, B, C, and D which change color according to nature of the solution. If the indicator of hibiscus rosa-sinensis after the drop of the solution turns red means that the solution is an acid solution, if it turns green then the solution is base. Then if the turmeric indicator drops the solution and changes color to orange then the solution is base, if it remains yellow then the solution is acid.

Based on the table, the students are given a question to identify which solution is acid and which is base and the student must write down the reason. This issue goes into aspects of context, competence (interpreting data and scientific evidence), and knowledge (content and epistemic). Overall, as many as 40,0% students can answer

correctly. Their false answer is because of students does not know what color changes occur on each indicator when added with an acid and base solution.

Question number 4 contains a table about pH data from some solutions is pH of solution A = 5; solution B = 2.7; solution C = 4.5; solution D = 3; solution E = 3.7. Based on these data, students were given a question to sort the solution which has the highest H^+ concentration up to the lowest.

In order to do this, students must work on the formula pH = -log [H^+]. This issue contains aspects of context, competence (interpreting data and scientific evidence), and knowledge (content and procedural). The correct answer is that after calculating the concentration by using the formula pH = -log [H^+] obtained the result that concentration of solution A = 10^{-5}; solution B = $1{,}995 \times 10^{-3}$; solution C = $3{,}16 \times 10^{-5}$; solution D = 10^{-3}; solution E = 2×10^{-4}. So the solution that has the highest concentration of H^+ to the lowest is solution B > solution D > solution E > solution C > solution A. Students who answer correctly on this matter amounted to 40,0%. Students who answer is wrong because students do not know how the procedure used to obtain H^+ concentration and other possibilities that students are not careful in calculating.

Taken together, the question used covers the context aspect; aspects of competence that include explaining the phenomenon scientifically, interpreting data and scientific evidence; aspects of knowledge that include content, procedural and epistemic knowledge. The context aspect is used to assess students' understanding of the processes and practices involved in advancing scientific knowledge [4].

The students' scientific literacy assessment is based on scientific competence that includes identifying scientific issues, explaining scientific phenomena and using scientific evidence [15]. Aspects of competence explain the phenomenon scientifically that aims to train students to have some ability that is a) remind and apply appropriate scientific knowledge; b) identifying, producing, and using a variety of clear models and representations; c) make and justify predictions appropriately; d) propose a clear hypothesis; e) explain the potential implications of scientific knowledge for society [4]. If it is associated with question 2, then that is where the students are trained to have the ability to conduct an investigation which means the students can identify, produce information so that students can answer how the antacid process in overcoming heartburn and students can identify the compounds contained in the reading into in acid or base solutions.

While the competence aspect to interpret the data and scientific evidence is trained to the students so that the students have the ability to: a) change the data from one type of presentation into another presentation type; b) analyze, interpret, and draw appropriate conclusions; c) identify assumptions, evidence, and reasoning in the texts of science; d) distinguish arguments based on scientific evidence and theory with those based on other considerations; e) evaluating arguments and scientific evidence from different sources (eg newspapers, internet, and journals) [4]. Based on the questions given, questions 3 and 4 include aspects of competence to interpret data and scientific evidence. In question number 3, students are trained to analyze and interpret the data contained in the table. Students can analyze some of these solutions and change the color of each indicator so that students can determine which solution is acid and which is base and for question number 4 students can present data starting from pH data then students can change it in the form of concentration data.

Aspects of knowledge is contained in the matter consists of content knowledge, procedural and epistemic. Content knowledge relates on knowledge and understanding of clear ideas and theories. So students should have an understanding of the content of the reading so that students can answer correctly. For example, in question number 1, students are given a matter of reading the development of acid-base theory after reading the reading the students can give an answer which compound which includes Arrhenius, Bronsted Lowry, Lewis, and of course students also know the reason why the compounds belong to the theory- the theory.

The procedural knowledge aims to find out how students understand the procedures used to solve problems. If it is related to the given problem that is number 4, then the student must have an understanding of how to calculate the concentration of H^+ if known pH of a solution. As for epistemic knowledge, it is basically aimed at measuring students' understanding of the role of construction, defining certain important features in the process of developing science.

The next aspect is attitude. Attitudes toward science play an important role in shaping student's perspective, attention and response to science and technology, as well as the issues that affect it [4]. Attitude aspect is measured by using questionnaire. This questionnaire contains 10 questions that ask about chemistry lessons. Percentage of this aspect reached 30-40% is still relatively low.

CONCLUSIONS

The results showed that the scientific literacy skills of SMA Muhammadiyah 10 Surabaya students is still low, as evidenced by the percentage of values from four questions covering aspects of context, competence, knowledge of 53,3%; 33,3%; 40,0%; 40,0%. While the percentage aspect attitudes reach 30-40% is still relatively low. Based on these results can be concluded that all aspects of scientific literacy skills is still relatively low, this is because the unavailability of learning devices that can improve the skills of scientific literacy, so this research can be used as a basis for developing learning devices to be more effective and optimal in improving the skills of scientific literacy.

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