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Chemical Literacy of High School Students: Analysis of Cognitive Abilities on Colloid Material

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Abstract: The development of science, technology, and society requires humans to have skills beyond literacy and numeracy that are needed to survive. Scientific literacy is the focus of learning in the 21st century. Currently, the scientific literacy index of students in Indonesia is still low. Chemistry is a part of science. Chemical literacy is the ability of students to identify, analyze, and process chemical concepts to solve everyday problems and communicate scientifically the chemical phenomena that occur around them. Colloidal material in chemistry learning has some abstract concepts close to everyday life. So the purpose of this study was to determine the chemical literacy ability of students on colloidal material in North Aceh and Lhokseumawe. The subjects of this study were 217 students of class XII, in SMA North Aceh and Lhokseumawe. The instrument used in this study is a chemical literacy question in the form of a description consisting of 8 PISA standard chemical literacy questions. The result of this research is that the highest student answers are on the literacy scale with nominal criteria, while the lowest is multidimensional criteria. According to the distribution of chemical literacy scores in the Aceh region, the highest was in the medium-grade category with 142 students, and the lowest was in the high-grade category with 14 students.

Keywords: Chemical literacy; Cognitive abilities; Colloid

Introduction

The development of science, technology, and society requires humans to have skills beyond literacy and numeracy needed to survive. It is hoped that through education, science and technology will act as a bridge with the environment and play an active role as highly skilled human resources. Science in this case is the science of natural products (IPA), society, and technology. The various scientific competencies mentioned above are summarized in the concept of 'scientific literacy. The purpose of scientific literacy is to build a scientific literacy community, especially on social issues. In addition to mastering scientific concepts, thinking skills are also needed (Ratini et al., 2018; Suwono et al., 2017; Vogelzang et al., 2020). One of the common goals of any education system itself is for students to acquire scientific literacy (García-Carmona et al., 2018; Jgunkola et al., 2013; Queiruga-Dios et al., 2020).

Scientific literacy is the focus of learning in the 21st century. Science consists of three inseparable elements: products, scientific processes, and scientific attitudes. Science as a product means organizing facts, concepts, procedures, principles, and natural laws. Science as a process describes that scientific knowledge is obtained from a scientific process or scientific work. Science as an attitude means the scientific attitude that underlies the scientific process that helps produce scientific products. These factors measure a student's basic science knowledge (Dinan Thompson et al., 2015; Goss et al., 2022).

PISA defines scientific literacy as the basis of the ability to deal with scientific topics and ideas as a reflective citizen. Scientific literacy includes the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically. It emphasizes the importance of being able to apply scientific knowledge to real-world situations (OECD, 2017). PISA 2018 results show that, on average, 15-year-old students in OECD countries are literate when faced with literacy tasks that require them to understand implicit cues regarding content and resources. The degree of ability to successfully distinguish between fact and opinion. While that number has increased from 7% in 2000, the demand for literacy has fundamentally changed (Program for International Student Assessment (PISA), 2021)

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Scientific literacy is the ability to engage with scientific topics and scientific ideas, and the ability to think logically reflexes (Aulia et al., 2018; Cahyana et al., 2019). Scientific literacy is also a skill that students need to analyze and apply scientific concepts to solve problems in everyday life (Ekantini et al., 2018; Jufrida et al., 2019; Vogelzang et al., 2020). The low scientific literacy of students in Indonesia is suspected because the curriculum, learning process, and assessment carried out do not support the achievement of scientific literacy (Asikin et al., 2019; Jufri et al., 2019; Rubini et al., 2018). Assessment is an important aspect of educational practice and accountability systems across compulsory education (Dinan Thompson et al., 2015; Goss et al., 2022). Assessment literacy emerged as an early contribution to the general education literature (Coombe et al., 2020; Inbar-Lourie, 2012). About the development of students' scientific literacy, the development of scientific literacy assessment tools is very important to familiarize students with issues in the field of scientific literacy (Chasanah et al., 2022; Muniroh et al., 2022; Rusilowati et al., 2018).

Chemistry tends to focus on scientific science, preventing students from seeing science as integrated with the environment, technology, and society (Fitria et al., 2018). Chemistry is a subject that cannot be separated from the environment. Chemistry is not only a collection of facts and principles but also includes methods for obtaining these facts and principles and their attitudes. Things must be understood not only through facts and principles but through theoretical processes and real-life applications (Aisah et al., 2020).

The low index of scientific literacy of students in Indonesia is due to their lack of attention to the socio-cultural environment. In addition, there is still a lot of content, context, and the process of learning chemistry that has not been realized as a learning resource to develop the field of scientific literacy into the four main disciplines. namely scientific content, scientific competence or process, the context of the application of science, and attitudes (Dewi et al., 2019). Chemical literacy is the ability of students to identify, analyze, and process chemical concepts to solve everyday problems and communicate scientifically the chemical phenomena that occur around them (Imansari et al., 2018; Mellyzar et al., 2022; Perkasa et al., 2016).

One of the chemicals is the colloid system. The colloidal system has some abstract concepts and some concrete concepts because it is close to everyday life and has terms that are difficult to understand (Marfu'ah et al., 2018; UZ et al., 2019). The colloidal system is a chemical material that is studied in high school. Colloids teach the difference between colloids, solutions and suspensions, types of colloids, colloid properties, colloid manufacture, and the role of colloids in everyday life and industry (Andromeda et al., 2019).

Chemistry is a science subject that is related to real life. One of the chemical materials with abstract concepts athatcan be exemplified in life is colloidal material. For this reason, it is necessary to know how far the students' level of chemical literacy is. So it is necessary to analyze students' chemical literacy skills on colloidal material to measure the level of chemical literacy in students.

Method

The type of this research is descriptive qualitative. The subjects of this research are 217 class XII students, aged 18-20 years who come from SMA Negeri 1 Muara Batu, SMAN 2 Kesuma Bangsa, MAN Lhokseumawe, and SMAN 4 Lhokseumawe. The students were selected randomly. Each of these schools represents a top-type school (high grade/favorite), and a medium-type school (middle/medium grade).

Table 1. Scientific Literacy (Shwartz et al., 2006)

Scale	Information
Scientific illiteracy	Students who cannot relate to, or respond to a reasonable question about science. They do not have the vocabulary, concepts, contexts, or cognitive capacity to identify the question as scientific
Nominal scientific literacy	Students recognize a concept as related to science, but the level of understanding clearly indicates misconceptions
Functional scientific literacy	Students can describe a concept correctly, but have a limited understanding of it
Conceptual scientific literacy	Students develop some understanding of the major conceptual schemes of a discipline and relate those schemes to their general understanding of science. Procedural abilities and understanding of the processes of scientific inquiry and technological design are also included in this level of literacy
Multidimensional scientific literacy	his perspective of scientific literacy incorporates an understanding of science that extends beyond the concepts of scientific disciplines and procedures of scientific investigation. It includes philosophical, historical, and social dimensions of science and technology. Here students develop some understanding and appreciation of science and technology regarding its relationship to their daily lives. More specifically, they begin to make connections within scientific disciplines, and between science, technology, and the larger issues challenging society

The instrument used in this study is a chemical literacy question in the form of a description consisting of 8 PISA standard chemical literacy questions where each question consists of 3 questions. Students' answers

are categorized into illiteracy, nominal, functional, conceptual, or multidimensional scales. Each student's answers are grouped and given a percentage to see the level of chemical literacy based on indicators that are percentages according to the scientific literacy scale which can be seen in Table 1. In working on the questions, students are conditioned by teachers in each school so that they do not communicate with each other.

Result and Discussion

The results of the analysis of the answers of 217 class XII students from the question of chemical literacy in the form of a description, based on the literacy scale, the distribution of students' scales were obtained with the categories of multidimensional, conceptual, functional, nominal, and literacy as shown in Table 2.

Table 2. Distribution of Student Scales Based on the Scale of Literacy

Category	Items							
	1	2	3	4	5	6	7	8
Multi-dimensional	0	0	0	0	0	0	0	0
Conceptual	120	86	49	86	86	71	68	34
Functional	25	79	139	79	79	104	109	162
Nominal	37	26	15	26	26	22	21	11
Literacy	35	25	14	25	25	21	20	10

The detailed description from table 2 is that each question has a different distribution of students in answering the question, where in each question there are 10 to 162 students who answer the question, so n but in the multidimensional category no one can answer the question. The process of implementing the research as shown in Figure 1. Furthermore, the percentage of student answers according to the literacy scale can be seen in Figure 2.

Based on Figure 2 shows that the results of the average percentage of students' answers according to the literacy scale are different. The multidimensional category was obtained by 0.00%, the conceptual category was obtained by 10.14%, the functional category was obtained by 34.58%, the nominal category was obtained by 44.67%, and the Literacy category was obtained by 10.61%. From the graph, it is known that the highest percentage of student answers is the nominal criterion literacy scale, while the lowest is the multidimensional criterion literacy scale.

So from these results, the achievement in the nominal category shows that students recognize concepts related to science, but understanding clearly shows misconceptions and students do not understand science, not only scientific concepts and scientific research methods. however, students are not aware of other aspects of science such as philosophy, history, society, etc (Shwartz et al., 2006). The percentage distribution of chemical literacy scores in the Aceh region is shown in Table 3.

Figure 1. Reseacrh implementation

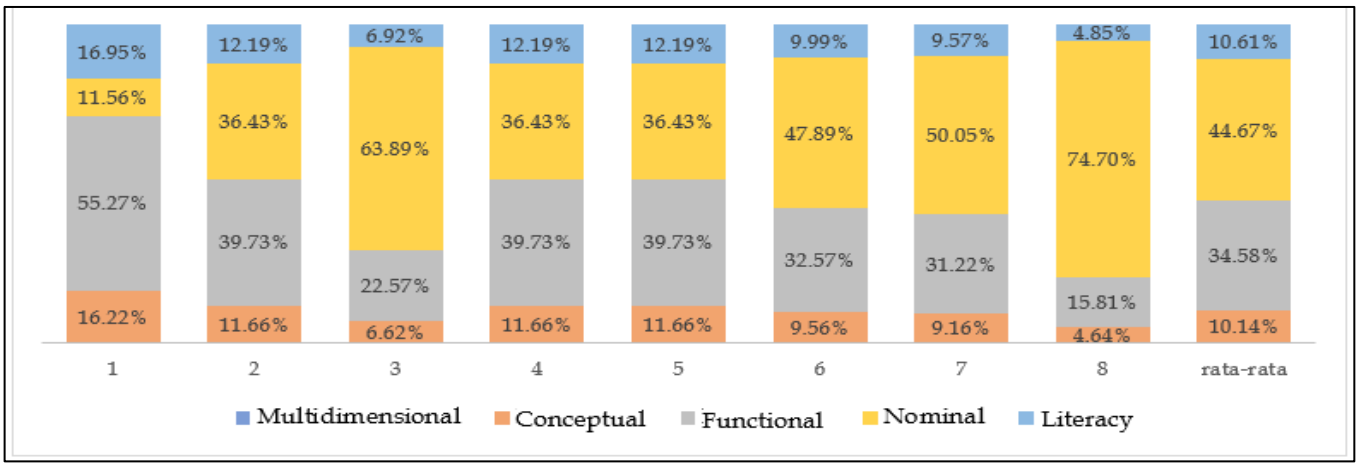

Figure 2. Percentage diagram of student answers appropriate literacy scale

Table 3. Distribution of Chemical Literacy Values in the Aceh Region

Category	Range of value	Students	Percentage
Low	0-33.33	61	28.11
Medium	33.34-66.66	142	65.44
High	66.67-100	14	6.45

The results from table 3, namely the distribution of chemical literacy scores in the Aceh region in the low-value category has a value range of 0-33.33 there are 61 students with a percentage of 28.11%, while in the medium grades have a value range of 33.34-66.66 there are 142 students with a percentage of 65.44%, and in the high-grade category having a value range of 66.67-100, there are 14 students with a percentage of 6.45%. So the distribution of chemical literacy values in the Aceh region is the highest in the medium category and the lowest in the high category

The percentage results show that students in North Aceh and Lhokseumawe districts have poor chemical literacy skills. This is evidenced by the majority of students who achieve literacy levels in the medium category and students in the low category more than those in the high category. fun and stimulating, educating and improving students' thinking skills (Pantiwati et al., 2016). In addition, one of the skills that students must develop as they learn is process skills. Process capability is the ability needed to face global capabilities. Dimensions the ability of chemical science process skills is an important component that must be possessed by students because it includes cognitive or intellectual, manual, and social skills used in problem-solving. Scientific process skills are suspected to be correlated with critical thinking skills because they are closely related to concept mastery. Students must have scientific process skills to better understand chemical concepts. Scientific process skills also support students' life skills and support their future lives (Sari et al., 2021).

Conclusion

The results of the analysis of the chemical literacy ability of high school students on colloidal material at SMA Negeri 1 Muara Batu, SMA N 2 Kesuma Bangsa, MAN Lhokseumawe, and SMAN 4 Lhokseumawe and from chemical literacy questions in the form of descriptions, based on the literacy scale with the categories of multidimensional, conceptual, functional, nominal, and literacy it was found that the highest student answers were on the nominal criteria literacy scale with a total percentage of 44.67%, while the lowest was on the multidimensional criteria literacy scale with a total percentage of 0.00%. According to the distribution of chemical literacy scores in the Aceh region, the highest was in the medium grade category with 142 students and a percentage of 65.44, and the lowest was in the high-grade category with 14 students and a percentage of 6.45.

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