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Socio-Scientific Issues Using Two-Tier Instruments Based on Literacy Analysis

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ABSTRAK

Literasi kimia penting bagi seseorang untuk memahami permasalahan ilmiah yang terjadi dalam kehidupan sehari-hari sehingga dapat memilih keputusan yang bijak dalam menyelesaikannya. Tujuan yang ingin dicapai dalam penelitian ini adalah menganalisis kemampuan literasi kimia siswa pada materi asam basa dengan menggunakan instrumen pilihan ganda dua tingkat berbasis SSI. Desain penelitian yang digunakan adalah metode deskriptif kualitatif. Sampel dalam penelitian ini diambil atau dipilih dengan menggunakan teknik purposive sampling. Teknik pengumpulan data yang digunakan peneliti berupa tes dan wawancara. Langkah-langkah yang dilakukan untuk menganalisis data adalah pengumpulan data, reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian ini menunjukkan bahwa 1. Hasil tes literasi kimia siswa pada materi asam basa menunjukkan bahwa sebanyak 15% siswa berada pada kategori tinggi, 62% siswa berada pada kategori sedang, dan 62% siswa berada pada kategori sedang, dan Sebanyak 23% siswa berada pada kategori rendah. 2. Literasi kimia siswa cukup pada aspek isi (79%), konteks (70%), HOTS (69%), dan sikap (66%). Subindikator yang paling banyak dikuasai siswa pada indikator konteks adalah menganalisis strategi dan manfaat aplikasi kimia. Pada indikator HOTS, keterampilan siswa yang paling dominan adalah bertanya dan mencari informasi masalah kimia. Indikator sikap menunjukkan pencapaian yang paling rendah diantara indikator lainnya karena kurangnya minat siswa terhadap permasalahan yang berkaitan dengan kimia.

ABSTRACT

Chemical literacy is important for someone to have to understand scientific problems that occur in everyday life so that they can choose wise decisions in solving them. The objectives to be achieved in this study are to analyze the students' chemical literacy skills on acid-base material using a two-tier multiple-choice instrument SSI based. The research design used is a descriptive qualitative method. The sample in this study was taken or selected using a purposive sampling technique. Data collection techniques are used by researchers in the form of tests and interviews. The steps taken to analyze the data are data collection, data reduction, data presentation, and drawing conclusions. The results of this study indicate that 1. The results of the students' chemical literacy test on acid-base material showed that as many as 15% of students were in the high category, 62% of the students were in the medium category, and 23% of the students were in a low category. 2. Students' chemical literacy was sufficient in the aspect of content (79%), context (70%), HOTS (69%), and attitudes (66%). The sub-indicator that students mastered the most in context indicators was analyzing the strategies and benefits of chemical applications. In the HOTS indicator, the students' most dominant skills are asking questions and seeking information on chemical issues. The attitude indicator shows the lowest achievement among other indicators due to the lack of student interest in issues related to chemistry.

1. INTRODUCTION

The times have brought many changes in various fields of life. The 21st century is full of complex demands and challenges. Nowadays, research related to scientific literacy has received a lot of attention from researchers (Marmoah & Poerwanti, Suharno, 2022; Radovanović et al., 2015). This is because

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scientific literacy is one of the basic life skills that must be mastered by 21st- century society. Scientific literacy is importantly used to solve various problems related to science and technology (Krejci et al., 2020; Yaacob & Lubis, 2022). The 2013 curriculum states that education should not separate students from their environment so that development is based on educational principles that are relevant to the needs and environment of students. This principle is very closely related to chemical literacy (Anggraeni, A.Y., Wardani, S., & Hidayat, A, N, 2020; R. K. Dewi et al., 2019). But in reality, the 2013 curriculum is expected to not be implemented as expected. This is evidenced by the results of the PISA (Program for International Student Assessment) test which shows that Indonesia is still in the low category (Ambarita et al., 2018; Anagnostopoulou et al., 2012). In addition to the 2013 curriculum, another policy carriedout by the government to improve student literacy is abolishing the National Examination (UN) and replacing it with a Minimum Competency Assessment (AKM) (Herkusumo, 2011; Sudarsana et al., 2019). The purpose of AKM is to determine or measure students' reading and numeracy literacy skills. Literacy is a basic skill that must be possessed by the community21 to be able to contribute and compete properly (Hidayah et al., 2021; Iswara et al., 2022). Scientific literacy is to use of scientific knowledge (scientific knowledge), basic ideas, and evidence-based conclusions to understand and make decisions to solve problems that occur in the environment. Chemical literacy includes four main aspects, namely: 1. knowledge of chemistry and scientific ideas, 2. chemistry in context, 3. higher order thinking skills, and 4. affective aspects (R. K. Dewi et al., 2019; Nardo et al., 2022).

Chemical literacy assessment needs to be carried out to analyze students' ability to apply a chemical concept in dealing with a problem, so it is not limited to the level of understanding and memorization alone. Chemical literacy assessment is also strongly encouraged to be able to activate students' analytical thinking skills. The results of the analysis of chemical literacy can be used as a basis for reflection and evaluation of the learning process. Therefore, a test instrument is needed that can analyze chemical literacy (Ad'hiya, E., & Laksono, 2020; Sadhu, S., & Laksono, 2018). By far, the most commonly used test instruments are multiple- choice and explanation. However, both of these measuring tools have many shortcomings, so it is necessary to use a more effective measuring tool. Based on research conducted by previous study two-tier multiple choice (92.54%) has a higher level of effectiveness to be used as an instrument in measuring Science Process Skills compared to other instruments such as ordinary multiple choice (59.70%) and short answer (16.41%) (Scotti di Uccio et al., 2019; Xiao et al., 2018). The same thing was also found in a study conducted by other study that the two-tier multiple choice type was more effective in detecting students' misconceptions on the Chemical Bond material compared to three-tier multiple choice, and four-tier multiple choice (Rintayati et al., 2020).

Two-tier multiple choice is an objective test with two levels.The first level is multiple choice and the second level is open- ended questions which are the explanation reasons for the questions about the first level. This type of test instrument has several advantages that can be considered a good measuring instrument. The advantage is that students give reasons for choosing answers at the first level so that they guess the answers, are easier to assess, are more objective, and can be used to measure students' abilities more accurately (Rintayati et al., 2020; Scotti di Uccio et al., 2019). Chemistry is the study of matter, changes in matter, and the energy that accompanies these changes.An understanding of chemistry allows us to understand and explain the phenomena that occur around us. The 21st-century society is expected to be able to think critically, contribute to society, and make important scientific-based decisions (Linda et al., 2018; Nugraha et al., 2020). Issues that involve the dimensions of science (including chemistry) and which also give rise to various social, political, economic, and ethical considerations are often called Socio Scientific Issues (SSI). According to the narrative above, the discussion of chemical literacy has a very close relationship with SSI. The ability to apply science in the field of chemistry can be used to solve socio-science problems (Habig, 2020; Purnamasari et al., 2020). Previous study conducted a study where the results stated that students with good scientific literacy have a high level of independence, concern, and responsibility for scientific issues that develop in society and can contribute to providing solutions to these problems (C. A. Dewi et al., 2019). Broadly speaking, it can be said that the main purpose of scientific literacy is to solve the socio-scientific issues that develop in society. Acid-base material was chosen to analyze SSI-based chemical literacy because it fulfills three principles of content selection based on PISA, namely (1) relevant to real daily life situations; (2) still little relevance for the next decade; and (3) concepts related to process competence (Goeltz & Cuevas, 2021; Hong & Talib, 2018). Acid-base material contains factual, conceptual, procedural, and metacognitive knowledge, concrete and abstract concepts, andskills that are widely applied in everyday life (Aufa et al., 2021; Barke et al., 2008). Theconcept of acid-base can also be explained by several Socio Scientific Issues that are currently happening, including acid rain, ocean acidification, global availability of clean water, loading of aerosols into the atmosphere, and so on. Chemical literacy analysis based on Socio-Scientific Acid- base material will be carried out in one of the high schools in Pacitan. This is based on the geographical conditions of Pacitan Regency which may

experience socio-science problems in the future. So it is necessary to prepare students with chemical literacy who can understand and contribute to solving these problems. Things that might happen in Pacitan are ocean acidification, where Pacitan Regency directly faces the Indian Ocean in the south and most of the population has a livelihood as fishermen. The Pacitan landscape is also surrounded by calcareous cliffs and mountains which will cause natural disasters if exposed to acid in the long term. Therefore, it is necessary to understand the issue of ocean acidification to prevent and mitigate the impacts that occur in order to cause losses in various fields. Based on the various explanations above, the author intendsto conduct an investigation related to student literacy on acid- base material with the help of a two-tier multiple choice instrument based on SSI. The objectives to be achieved in this study are to analyze the students' chemical literacy skills on acid-base material using a two-tier multiple-choice instrument SSI based.

2. METHODS

The research design used is a descriptive qualitative method. Descriptive research aims to determine thecircumstances or conditions whose results are presented in a straightforward manner and as they are in accordance with the reality on the ground in the form of words based on a scientific context (Arikunto, 2007). Qualitative research is used to obtain and understand information from research in- depth and depth through descriptions in the form of words. The use of descriptive qualitative in this study is expected to describe the state of students' chemical literacy in acid-base material well. The sample in this study was taken or selected using a purposive sampling technique, which is a non-random sampling technique where the sample is determined by the researcher himself with certain reasons and criteria. The sample selection uses a purposive sampling technique based on certain characteristics that are determined based on problems in the study. Studentswho can be used as research samples are students who have obtained acid-base material before. The sample in this study was 69 students of grade 11 MIPA. Data collection techniques are used by researchers in the form of tests and interviews. The steps taken to analyze the data according to the theory of Miles and Huberman are data collection, data reduction, data presentation, and drawing conclusions. The steps in this research begin with making a research design, compiling instruments, collecting data, and finally compiling a research report.

3. RESULTS AND DISCUSSION

Results

The results of the descriptive analysis obtained from the chemical literacy test on acid-base materials have been summarized in Table 1.

Table 1. Results of Descriptive Statistical Data Processing Test Result Score

Statistic	Result
Average	73
Variance	483.464
Highest Score	100
Lowest Score	29
Score Range	71
Standard Deviation	22
Mode	95

According to Table 1, it can be seen that the average score obtained by students is 73 with the highest score of 100 and the lowest score of 29. The results of the chemical literacy test are also categorized into three namely high, medium, and low so that the frequency and percentage in each category are obtained as show in Table 2. Base on Table 2 show the highest percentage of chemical literacy test results were students with moderate category (62%), followed by students with low category (23%), and the lowest percentage was students with high chemical literacy category (15%). The percentage of students' chemical literacy is reviewed in more detail based on the score on each chemical literacy indicator. The chemical literacy indicator consists of 4 indicators and 11 sub-indicators. The results of the students' chemical literacy analysis on each indicator or aspectare shown in Table 3.

Table 2. Category of Student Chemistry Literacy on Acid- Base Materials

Criteria	ChemicalLiteracy Category	Total Students	Percentage(%)
Score > 95	High	10	15%
95 < Score < 51	Medium	43	62%
Score < 51	Low	16	23%

Table 3. Results of Student Chemical Literacy Analysis

Chemical LiteracyIndicator	Students Score Percentage (%)	Category
Chemistry in Content	79	Good
Chemistry in Context	70	Adequate
Higher Order Thinking Skills	69	Adequate
Attitude	66	Adequate

Base on Table 3, the results of the test using a two-tier multiple choice instrument based on Socio Scientific Issues showed that students' chemical literacy in the aspect of chemistry knowledge and scientific ideas (content) was in a good category (79%), and the chemical aspect in context was in the sufficient category (70%), the aspect of high-level learning skills is in the sufficient category (69%), and the attitude aspect is in the sufficient category (66%).

Discussion

Content Indicator

The content indicator has the highest achievement (79%). This means that students are better able to master mathematical concepts and calculations compared to their application (Ahdhianto et al., 2020; Demirbaş & Şahin, 2022). However, during the interview, the students had difficulty and made a mistake in explaining the science concepts they had learned. Based on interviews, students had difficulty understanding the concept of chemistry because the teacher only sent material in written form when online learning took place. A passive learning environment makes students not have a complete understanding of the concept and do not know its application (Al-Gindy et al., 2020; Rahmawati, 2020). The use of SSI in learning can help students to apply their chemical knowledge in describing or understanding problems. So that students know the benefits of learning chemistry by applying it to concrete problems, not just understanding abstract concepts without knowing their use in everyday life (Mutakinati et al., 2018; Rosmani & Halim, 2017).

The context indicator shows a percentage of 70% by category. The results are similar to the research conducted by previous study that generally students' chemical literacy on context indicators is lower than on content indicators (Anggraeni, A.Y., Wardani, S., & Hidayat, A, N, 2020). According to other students in Indonesia find it easier to memorize or remember material compared to applying their knowledge to contextual matters (Hanik et al., 2018). Students are also usually faced with calculation problems on acid-base material, not literacy-based questions. So that they have difficulty in working on scientific literacy questions. This is because the admission by one of the students has difficulty when answering questions that are not familiar with the form of many reading questions with context. Socio Scientific Issues can be used as a context in learning chemistry because it makes students do more complex thinking than just remembering memorized content, factual knowledge, or applying simple algorithms (Kamarudin & Djafri, 2023; Kinslow et al., 2018). Understanding SSI requires scientific concepts, principles, and practices to teach students to study a science and relate it to the context of problems in everyday life that concern the needs of many people.

HOTS

Chemical literacy on indicators of high-level learning skills has resulted in the sufficient category (69%). Based on the chemical literacy test and interviews conducted, students lack the ability to think highly in analytical thinking to apply their knowledge and solve problems in different situations. So it is important to make efforts to improve learning and thinking skills. Learning that is considered to be able to help students achieve chemical literacy is a teaching and learning activity that pays attention to aspects of applying chemistry in everyday life (Anggraeni, A.Y., Wardani, S., & Hidayat, A, N, 2020; Shwartz et al., 2006). Based on this description, it can be said that the use of socio-science issues in learning can improve students' skills in higher-order thinking. This is in line with research conducted by previous problems with the SSI context in learning if designed effectively can improve students' understanding of science concepts, the nature of science, and higher-order thinking skills (critical thinking and problem solving)

(Abosalem, 2015; Muhali, 2019). The use of SSI in acid-base learning can increase students' interest in learning. Constructivistically, students will acquire, acquire, and apply the knowledge that solves problems related (Ridwan et al., 2021; Yerimadesi et al., 2019). So it can be said that SSI can overcome various problems in acid-base learning such as low understanding of concepts, lack of higher order thinking skills, and low perception of acid-base material in everyday life (Kamin et al., 2015; Yu et al., 2021). Based on the chemical literacy test and interviews conducted, it is certain that there are still many students who are not proficient in attitudes, especially in showing their interest in chemical issues. Chemical literacy in attitude indicators that show unsatisfactory results is not in accordancewith previous studies (Anggraeni & Akbar, 2018; R. K. Dewi et al., 2019). The results of previous studies suggest that student literacy in attitude indicators tends to be high or equivalent to other aspects. However, in this study, skills in attitude indicators showed the lowest level of achievement.

The low attitude or interest of students towards attitude issues from the results of the interview. At the time of the interview, most of the students claimed to be interested in environmental issues related to chemistry but students had difficulty when asked to give examples and explain the issue. Students also experience misconceptions in understanding the environment. For example, there is an explanation that explains that the depletion of the ozone layer occurs due to the effect of greenhouse gases, whereas refrigeration or refrigerants should be responsible for the depletion of the ozone layer (Rao et al., 2019; Tarng et al., 2022). This is because in the learning process students are less known about the nature of chemistry in everyday life. Students assume that chemistry lessons only contain concepts and theories that will not be used in life, thereby reducing interest in chemistry issues. Previous study explained in his research that there was a significant relationship between students' interest in learning science and their literacy (Dou et al., 2018). This is in line with the results of research namely that there is a relationship between attitudes and scientific literacy, namely interest, enthusiasm, and student participation in science learning to improve scientific literacy (Aprilliyah, 2014; Maruti, 2022). If students have a good attitude toward chemistry, then they will pay more attention, give importance, and follow the lesson well so that curiosity will grow on issues related to chemistry (Irwansyah et al., 2019; Ural, 2016). Therefore, interesting learning is needed, for example by including SSI in learning to increase student curiosity so thatit fosters a good attitude. Science issues canbe integrated into learning materials and curricula to support scientific literacy.

4. CONCLUSION

Based on data analysis conducted on the results of students' chemical literacy tests on acid-base material of students are in the medium category. Students are in the medium category. students are in the medium category. students are included in the low category. The chemical literacy of grade 11 MIPA students is still quite adequate in terms of content, context, HOTS, and attitudes. In the content indicator, the most dominant student skill is "conducting scientific investigations, making generalizations, and proposing theories to describe the phenomena of the universe". The sub-indicator with the best results on the context indicator is “analyzing the strategy and benefits of chemical application”. In the HOTS indicator, the most dominant student skill is "asking and seeking information about chemical problems". The attitude indicator shows the lowest achievement among other indicators due to the students' lack of interest in problems related to chemistry.

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