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Students' Chemical Literacy Ability of Senior High School in Gowa Regency

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Abstract: This research aims to describe chemical abilities in terms of content knowledge, chemical context, and higher-order learning skills of students on chemical equilibrium. This research is quantitative research with a survey method. The subjects of this research were students in six schools in Gowa Regency. The population in this study were all state high schools in Gowa Regency. The sampling technique is using random sampling after grouping schools based on accreditation. The instruments in this research were a chemical literacy ability test in the form of 20 multiple-choice objective questions. Chemists and chemical education experts carried out instrument validation. Empirical validation was carried out in class XI MIPA. The research results show that chemical literacy abilities in terms of content knowledge, chemical context, and higher-order learning skills are in the medium category.

Keywords: Chemical literacy; Senior High School; Students'

Introduction

Science comes from the word natural science or science, namely natural sciences whose studies include physics, chemistry, and biology, as well as other allied sciences. Science is a study that focuses on and explains natural phenomena and their interactions. Scientific literacy skills are used to (1) solve problems using scientific concepts obtained in education according to the level, (2) get to know the technological products students around and their impacts, (3) be able to use technological products and maintain them, and (4) creative in creating simplified technological results (Abidin et al., 2018).

Mastering scientific literacy is one of the goals of science learning (Hayati, 2017). Teaching special subjects in science education must contribute to training students to have scientific literacy skills. Therefore, chemistry learning must contribute to chemical literacy in particular and scientific literacy in general (Yamtinah et al., 2021). The development of chemical literacy is the goal of chemistry education and is an important skill in the 21st century (Sadhu et al., 2019).

Chemistry is the study of matter and its changes; it is also called a central science because basic knowledge of chemistry is important in various subjects. Chemistry is generally considered more difficult than other subjects, even in the introductory section. This is because chemistry has a special vocabulary that is quite abstract for students. Although the effects of chemical processes are often found in everyday life (Timberlake, 1991). Close the gap between students and chemistry can be done by designing chemistry learning that includes real-world contextual problems and involves science and technology (Cigdemoglu et al., 2015; Magwilang, 2016). Thus, students are expected to become familiar with the basic concepts of chemistry and be able to define these concepts, relate them to everyday life, and prevent their negative impacts (Celik, 2014).

Chemistry learning should be designed by optimizing literacy aspects. Choose chemistry topics that have a lot of relevance to students' lives. Chemistry topics also include declarative, procedural as well as epistemic knowledge; inquiry-based learning strategies; determining the relevant context, contemporary or socioscientific issues; determining the affective values

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and ways of learning of students in chemical literacy-oriented learning (Rahayu, 2017).

Chemical literacy abilities are one of the 21st-century skills that students are required to have in the current educational era. However, the results of TIMSS (Trends in International Mathematics and Science Study) which was carried out in 2015 showed that Indonesia was ranked 44th out of 49 countries with an average score of 397 out of 500 average international scores (Martin et al., 2016). These results are in line with research results which state that students' chemical literacy abilities are in the medium category (Darwis et al., 2019; Yulianti et al., 2019). The results of other research also show that the results of the analysis of students' chemical literacy in chemical equilibrium learning show that only a third of students have a good category, meaning that there are still many students who have chemical literacy abilities in the low category (Eny et al., 2019; Mellyzar et al., 2022).

Students' chemical literacy ability can be improved by being oriented towards students' interests, the relevance of chemistry life, and understanding inquiry-based content (Cigdemoglu et al., 2015; Kohen et al., 2020). In addition, interactions between student-learners and student-teachers enable collaboration in the construction of knowledge and competencies that support increasing chemical literacy (Cigdemoglu et al., 2017). The use of assessment in the learning process through the application of appropriate learning models and methods can improve students' chemical literacy abilities (Sadhu et al., 2018). Therefore, teachers must have high chemical literacy abilities, as well as other knowledge and skills to guide and direct students to have good chemical literacy (Dewi et al., 2019).

There are four main aspects of chemical literacy, namely content knowledge, chemistry in context, high-order learning skills, and affective aspects (Shwartz et al., 2006). Several studies have developed chemical literacy instruments which refer to the ability to understand and apply chemical knowledge in everyday life in terms of understanding three main aspects, namely knowledge of concepts, using chemical understanding in problem-solving, and applying chemistry in everyday life appropriately and effectively (Ad'hiya et al., 2018; Thummathong et al., 2016). Therefore, the instruments used must be able to measure chemical literacy according to its aspects by following the theoretical framework.

Based on theoretical studies on chemical literacy, what is meant by chemical literacy ability in this research is students' ability to utilize the chemical knowledge they have acquired by applying or connecting it with various issues or aspects in various fields related to chemistry in everyday life. Apart from that, you are also able to understand ideas or arguments from reading related to chemistry.

Method

This research is quantitative research with a survey method. In this research, the researcher quantitatively describes several tendencies, behaviors, or opinions of a population by examining a sample of that population. Then generalize or make claims about the population (Creswell, 2019). The population in this study were all students in class XI MIPA at State High Schools in Gowa Regency. The sample was determined using a cluster random sampling technique. Therefore, before selecting the sample, the population must first be determined and grouped based on accreditation. Then the sample selection is carried out randomly from the population group.

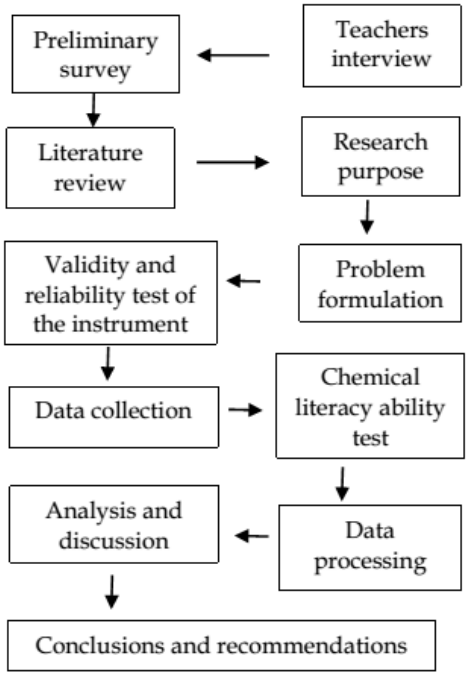

Figure 1. Flow diagram of the research process

The instruments of data collection are tools used by the researchers to collect data during research. The instrument used in this research was a chemical literacy ability test. The test instrument is in the form of objective multiple-choice questions totaling 20 chemical equilibrium questions.

A research instrument can be said to meet the requirements as a data collection tool if the research instrument is valid and reliable. Therefore, before use, validity and reliability testing are carried out first. Content validation is carried out by experts by looking at the suitability of the test items prepared with the core competencies and competency standards that have been determined. Validation of the contents of non-test

instruments is also carried out by asking for expert advice and seeing the suitability of the items with the indicators created. The instrument to be used is validated by two validators. The empirical validity of the instrument used in the chemical literacy ability test is carried out by giving the instrument to students other than the sample. This validity data processing is based on Item Response Theory (IRT) carried out using the Rasch Model via Winstep Software. An instrument is said to be reliable if the instrument can measure aspects that are measured repeatedly over a certain period, resulting in scores that tend to be consistent. Reliability in this research uses Cronbach's Alpha test statistics.

The data obtained was grouped based on chemical literacy ability criteria. Classification of chemical literacy ability test results based on categories Azwar (2012) presented in Table 1.

Table 1. Classification of Chemical Literacy Ability Test Results

Calculation Formula	Score Range	Category
X > Xi + 1.8 SBi	X > 83	Very high
Xi + 0.6 SBi < X ≤ Xi + 1.8 SBi	61< X ≤ 83	High
Xi - 0.6 SBi < X ≤ Xi + 0.6 SBi	39 < X ≤ 61	Medium
Xi - 1.8 SBi < X ≤ Xi - 0.6 SBi	17 < X ≤ 39	Low
X < Xi – 1.8 SBi	X< 17	Very low

Result and Discussion

Students' chemical literacy abilities are measured through multiple choice tests in the form of questions that apply chemical equilibrium material in the context of life. Each question measures chemical literacy indicators including chemistry in context, chemical knowledge content, and higher-order learning skills (HOLS). Perwitasari et al. (2017) revealed that if students can apply knowledge in everyday life with concepts accepted at school, then their chemical literacy abilities will be high. Below is presented data from the analysis of students' chemical literacy abilities in Table 2.

Table 2. Data on Chemical Literacy Ability Categories

Category	Percentage (%)
Very high	3.46
High	20.77
Medium	47.71
Low	23.98
Very low	4.08
Amount	100

Based on the results of descriptive analysis, students' chemical literacy abilities are in the medium category. This is because students are not yet fully able to apply knowledge in contexts that are relevant to everyday life. Other factors that can cause such results are the level of difficulty of the questions and the application of learning in class. Temporary Da et al. (2018) revealed that students' difficulties in understanding chemistry material were related to the learning methods used.

Below is presented chemical literacy data in terms of context, chemical knowledge content, and higher-order learning skills (HOLS). The results of the chemical literacy analysis for context aspects are presented in Table 3.

Table 3. Percentage of Achievement of Chemical Literacy Context Aspects

Context	Percentage (%)
Coral reef formation	59
Binding of oxygen in the blood	48
Tooth enamel	46
Manufacture of ammonia	47
Eggshell	48
Swimming pool and water storage tank	42
Average	48
Category	Medium

Based on Table 3, it can be seen that the highest context aspect of chemical literacy was achieved in the context of coral reef formation at 59% and the lowest was in the context of swimming pools and water storage tanks with a percentage of 42%. Overall chemical literacy abilities in context aspects are in the medium category with a percentage of 48%.

The results obtained show that there are still students who have difficulty answering questions. Students are not yet familiar with questions related to life around them, so students have difficulty working on story questions related to life around them. Students are used to questions that the teacher has explained so they experience difficulties if the teacher gives questions that are different from the examples. Students have difficulty analyzing the problems in the questions which make students lazy to do it (Kholifasari et al., 2020). This is possible because the learning they receive does not relate to chemistry content and everyday life, the questions given only focus on memorizing concepts and applying formulas (Sumarni et al., 2017). In fact, context-based tasks can provide students with the opportunity to solve problems and improve higher-level thinking by not only remembering limited facts (Parchmann et al., 2015).

The results of the chemical literacy analysis for the content knowledge aspect are presented in Table 4. Based on Table 4, it can be seen that the highest chemical literacy aspect of content knowledge is achieved in the content of chemical equilibrium reaction equations at 73%. Overall chemical literacy abilities in the content knowledge aspect are in the medium category with a percentage of 48%.

Table 4. Percentage of Achievement of Chemical Literacy Aspects of Chemical Content Knowledge

Content	Percentage (%)
Dynamic equilibrium	42
Chemical equilibrium reaction equations	73
K_c concentration equilibrium reaction equation	33
Factors that influence the shift in equilibrium	53
Determination of Kc value	36
Relationship between K_p and K_c	35
Relationship between K_p and K_x	53
Determination of the degree of dissociation	53
Homogeneous and heterogeneous equilibrium	49
Reaction rate graph at chemical equilibrium	56
Average	48
Category	Medium

The content aspect refers to chemical material as scientific knowledge and ideas. If you look at the results obtained, there are still students who have difficulty understanding chemical equilibrium material. This can be caused by students who only focus on memorizing the material, so they experience difficulty or confusion when the material is applied to questions related to life around them. In line with the results of Pratama et al. (2023), students' lack of optimal understanding of chemistry in context occurs because students only study chemistry using the rote method, so they are less able to integrate the chemical concepts they acquire at school with everyday phenomena. Pertiwi et al. (2022) also revealed that students in Indonesia are more accustomed to memorizing and less accustomed to applying the knowledge they have. This is thought to be because students tend to use memorization to master existing knowledge, rather than using their thinking abilities.

Providing material that only focuses on content aspects reduces students' motivation to learn. Apart from that, another factor that can cause students' low understanding of the chemical equilibrium of materials is that some students still do not properly understand the material which is a prerequisite for studying the equilibrium of materials, such as the concept of the mole. Students also have difficulty in working on calculation problems because working on these questions not only requires mathematical ability but also requires an understanding of chemical concepts and formulas.

The results of the chemical literacy analysis for the Higher Order Learning Skills (HOLS) aspect are presented in Table 5. Based on Table 5, it can be seen that the highest chemical literacy aspect of higher-order learning Skills (HOLS) is achieved in the argumentation indicator at 60%. Overall, chemical literacy abilities in the Higher Order Learning Skills (HOLS) aspect are in the medium category with a percentage of 50%.

Table 5. Percentage of Chemical Literacy Achievement Aspect of Higher Order Learning Skills (HOLS)

Aspects of Higher Order Learning Skills (HOLS)	Percentage (%)
Identify scientific information	49
Argumentation	60
Connecting scientific information	48
Analyze scientific information	42
Average	50
Category	Medium

The results above show that there are still students who are not able to analyze the questions on each chemical literacy test topic and relate them to the concept of equilibrium. Mathematical questions on the chemistry literacy test cannot be done directly by entering them into a formula. However, students are required to analyze the question regarding what is known in the question. When students are used to learning that applies it to life around them, students will also easily be able to analyze reading texts on each topic well. As a study states, connecting chemistry topics with everyday life can help consolidate chemistry concepts so that students understand chemistry concepts better and become very effective (Ilhan et al., 2016). It is just, Classroom learning has not fully taught students to have HOLS abilities (Pratama et al., 2023)

Students' ability to identify scientific information is in the medium category. This means that there are still students who are not able to identify the text in the questions given. The thing that might influence it is the student's initial knowledge. For example, students need to first understand the nomenclature of compounds, writing chemical reactions and other chemical content related to chemical equilibrium. According to (Arifin et al. (2017), several factors influence students not being able to think at a high level, including 1) limited conceptualization, 2) limited reasoning, 3) limited thinking, and 4) limited skills in solving problems.

Higher Order Learning Skills aspect is also measured through students' arguments regarding health and environmental issues on each topic related to the concept of equilibrium. Through learning that involves the surrounding life, students can be trained to make wise decisions in interacting with the surrounding environment. As explained by Hanson (2017), some of the answers from students taught context-based learning provide clear answers to environmental problems, by building appropriate reasoning. Contextual-based learning can encourage students to connect chemical concepts with everyday life. Students can learn to solve problems independently and have critical thinking skills by exploring and analyzing information (Anggraeni et al., 2020).

Conclusion

The chemical literacy abilities of high school students in Gowa Regency in terms of context, knowledge of chemistry content, and in terms of context, and Higher Order Learning Skills (HOLS) are in the medium category.

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Conflicts of Interest
The authors declare that there are no relevant conflicts.

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