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Description of Science Literacy Epistemic Knowledge Ability of Chemistry Education Students on the Material of Colligative Properties of Solutions

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Abstract
The ability of science literacy epistemic knowledge is a fundamental thing that must be owned by students in facing the global era to be able to meet the needs of life in various situations. Epistemic knowledge can be said to be a more advanced level of knowledge because epistemic knowledge is closely related to the process of knowledge construction. This study aims to determine the science literacy skills of chemistry education students on the material of colligative properties of solutions. The research method used was a descriptive quantitative method. The study used a sample of 25 samples of 6th semester and 4th semester students using purposive samples. Data collection techniques in this study through measurement techniques and direct communication techniques. The research instrument used in this research is a science literacy test that has been modified and adapted to the material of the colligative properties of the solution. The validation used in this study used construct validity and was validated by *judgment experts* in material and literacy with valid final results. The results of the research on the ability of epistemic knowledge of science literacy of chemistry education students FKIP Untan shown based on the test of science literacy skills with epistemic knowledge of science literacy on indicators explaining the process of scientific phenomena with an average percentage of 75% with sufficient category. Explaining observations of scientific phenomena with an average percentage of 74% with a sufficient category. Concluding scientific phenomena with an average percentage of 69% with a sufficient category. The overall total average of students' science literacy skills is 73.33% with a sufficient category.

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INTRODUCTION

In the era of society 5.0, the implementation of Natural Science learning is one part of education that plays an important role in shaping the ability to think critically, logically, constructively, innovatively, and universally. One of the goals of science learning is the achievement of a society that has science literacy skills (Sumanik et al., 2021). In today's digital era, science education is very helpful in the development of knowledge and technology and the discovery process in it. This is in accordance with the role of science education, namely preparing quality human resources. Science learning that applies science concepts is expected to train Indonesian students to use their understanding of scientific facts and link science, technology, and society in solving problems in their daily lives (Cerelia et al., 2021).

Science literacy by the Programme for International Student Assessment (PISA) is defined as the ability to engage with science-related issues, and with science ideas as a reflective citizen. (Fauziyah et al., 2021). A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires competence to identify scientific

questions, explain scientific phenomena, and interpret data and use scientific evidence (O. S. Indicators, 2019).

As for the aspects of science literacy, PISA identified three major dimensions of science literacy, namely (a) Science content, namely learners need to capture a number of key or essential concepts to be able to understand certain natural phenomena and changes that occur due to human activities. PISA asks questions that bring together the concepts of physics, chemistry, biology, and earth and space science (Earth and space science), (b) Science process, which is the process of science literacy in PISA examines the ability of learners to use scientific knowledge and understanding, such as the ability of learners to search for, interpret and treat evidence. PISA specifies the following three aspects of the science process in the assessment of science literacy, namely identifying scientific issues, explaining phenomena scientifically, and using scientific evidence, (c) Science context, namely science literacy emphasises the importance of recognising and understanding the context of science application, and being able to apply science in solving real problems faced, whether related to the child's personal self (for example food), the local community where the child is located (for example water supply), or life on earth more globally (for example global warming).

PISA divides science application areas into three groups, namely (a) life and health, (b) earth and environment, (c) technology. However, in reality, Indonesia's average science literacy skills are still low. This is based on the results of the PISA study that the average score of science literacy skills in Indonesia is still below the score of 500 (O. S. Indicators, 2019)

This condition indicates that Indonesia's ability is only at the stage of being able to use science knowledge on several problems with low cognitive levels, but not yet able to use their science knowledge on problems with higher cognitive levels (Kartimi & Winarso, 2021). This is also due to the weak ability of students in this case, students who are still unable to solve problems, especially in terms of identifying, understanding, and applying the basics of scientific knowledge to be applied in their daily lives (Wardhana & Hidayah, 2021)

Epistemic knowledge according to Duschl is the knowledge to construct and define the essential features for building knowledge processes in science and their rules in justifying knowledge formation (Dan & Depdendent, 2015) Epistemic knowledge is comprehensive of constructs and the role of constructs (O. S. Indicators, 2019), including explanations, analogies, models, reasoning, hypotheses and claims, among others. In summary, epistemic knowledge is closely related to the process of knowledge construction. Therefore, the discussion of epistemic knowledge is directly about the content of the knowledge content that is the substrate.

Epistemic knowledge can be said to be a more advanced level of knowledge that is strengthened by mastery of content knowledge and procedural knowledge. Content knowledge is knowledge that builds basic concepts and principles, procedural knowledge is knowledge obtained through tracing the components and processes of scientific inquiry that produce this knowledge. Epistemic knowledge is the highest knowledge where students examine (analyse) the process and products of scientific investigations (facts, concepts, principles, procedures, laws, theories, or models), sort and evaluate (evaluate), generate new ideas (synthesis) or conclusions (inference).

Solution chemistry course is a basic course in lectures in the Chemistry Education study programme. This course is said to be basic because it is an advanced course in basic chemistry that has been obtained in semester 1 and as a requirement for advanced courses such as high school chemistry, analytical chemistry, thermodynamics, chemical kinetics, and so on. Students must pass the solution chemistry course in order to be eligible to take advanced upper-level courses. However, over time the course is only used as a requirement to take advanced upper-level courses without understanding the concept in a sustainable manner even though

the lecture has applied the concept of science literacy in it. In solution chemistry courses, the focus of this research is on the colligative properties of solutions, because the colligative properties of solutions contain material that is certainly related / continuous with some of the above courses, for example, such as the decrease in freezing point and the increase in boiling point which will be the basis before learning more about thermodynamics.

The average scientific literacy ability of Chemistry Education students of FKIP Tanjungpura University class of 2021 in the aspect of content knowledge with the competence of identifying scientific questions of 39.62% is in the medium category, the aspect of procedural knowledge with the competence of explaining scientific phenomena of 26.38% is in the low category, and the aspect of epistemic knowledge with the competence of using scientific evidence of 23.33% is in the low category (Putri et al., 2022). With these data, it illustrates to researchers that chemistry education students of FKIP Untan have a decrease in terms of literacy skills so that to find out more about the science literacy skills of chemistry education students on the material of colligative properties of solutions.

METHOD

The study used a qualitative descriptive method, because it was appropriate to answer the problem under study with direct data sources and in accordance with those in the field, obtained from samples, namely chemistry education students class of 2020 and 2021 from a population of all chemistry education students at the Faculty of Teacher Training and Education, Tanjungpura University Pontianak. The chemistry education students referred to in this study are chemistry education students of the Faculty of Teacher Training and Education (FKIP), Tanjungpura University Pontianak class of 2020 and 2021 or students in semester 6 and semester 4.

Sampling and determination of samples in qualitative research is adjusted to certain considerations and objectives (purpose sample). Purposive sampling is a sampling technique with certain considerations (Etikan, 2016) The study used a sample of 25 samples of 6th semester and 4th semester students with certain considerations, namely with high, medium and low value categories who passed the solution chemistry course with grades A, B and C.

Data collection techniques using measurement techniques and direct communication. Tests in the form of descriptions and interviews as instruments used in this study. Essay tests are rarely used because they are considered difficult. Excessive use of objective test forms can reduce students' thinking skills because of the element of guessing in answering questions (Istyadji & Sauqina, 2023). Direct communication techniques in the form of semi-structured interviews to support research data and confirm student answers.

The data collection tools used in this study were science literacy tests and interview guidelines. The science literacy test instrument refers to several articles on the development of science literacy questions that have been constructively validated and adapted to the science literacy knowledge studied. There were 6 description questions. 1 question has an assessment rubric consisting of four answer key words with each answer key option that answers correctly is worth 1 and the wrong one does not get a score. From the results of the description test, the percentage of the total number of students who have science literacy skills on certain indicators is determined.

Percentage interpretation is descriptively quantitative based on the criteria of student science literacy test results. Data analysis is categorised into the category levels of very good, good, sufficient, less and very less which are presented in table 1.

Table 1. Category classification of student's science literacy skills percentage based on values

Classification	Percentage
86% - 100%	Very good
76% - 85%	Good
60% - 75%	Sufficient
55% - 59%	Less
<54%	Very Less

The indicators used are a modification of the instrument developed by (Mellyzar et al., 2022). The modification made is the adjustment of indicators on the knowledge used and adapted to the material tested. Science Literacy examined in this study is the ability of students' epistemic knowledge in applying their scientific knowledge to solve a scientific problem. To interpret and answer questions, students must be able to explain, describe, and conclude scientific phenomena. The modified indicators of science literacy skills are presented in Table 2.

Table 2. Indicators of students' science literacy epistemic knowledge

No	Indicators
1	Explaining the process of phenomena scientifically
2	Explain observations of scientific phenomena
3	Summarising scientific phenomena

The data obtained were then calculated per item so that the overall achievement of science literacy skills was obtained by calculating the average percentage who answered the questions correctly on each item. After analysing the indicators of science literacy, then the scoring of students' science literacy skills is carried out. The scoring value formula is shown in the following equation.

$$\frac{\Sigma \text{ total score obtained}}{\Sigma \text{ maximum score}} \times 100\%$$

Σ = Shows the total value of each type (total score and maximum score)

After obtaining the results of the science literacy test, the researcher classified the percentage based on the criteria for student science literacy test results. Data analysis was categorised into the category levels of very good, good, sufficient, less and very less.

RESULTS AND DISCUSSION

Analyze the Results

The results of the research data show that the total average obtained by students on the science literacy ability test is 73.33% with a sufficient category. The overall achievement of science literacy skills is obtained by calculating the average percentage of students who answer questions correctly on each item. The results of the calculation of the percentage of students who answered the questions correctly are presented in Table 3.

Table 3. Percentage and classification per item

Percentage of result based on number of questions	Percentage
1 (67%)	Simply
2 (81%)	Good
3 (69%)	Simply
4 (75%)	Simply
5 (73%)	Simply
6 (75%)	Simply
Average Percentage (73,3%)	Simply

Based on table 3, it is obtained that the average achievement of students' science literacy skills is 73.3% with a sufficient category. The acquisition of this data also provides an overview of the science literacy skills of chemistry education students at FKIP Untan on epistemic knowledge can be said to be sufficient. Epistemic knowledge contains an explanation or proof to find out the truth produced by science (Subaidah et al., 2019).

Average Epistemic Knowledge Ability Results

The research data related to students' science literacy skills on epistemic knowledge although the average category of the whole is sufficient, but there are significant differences shown through the percentage of results per question. The questions used are distributed into indicators as a reference in determining the types of questions and student results.

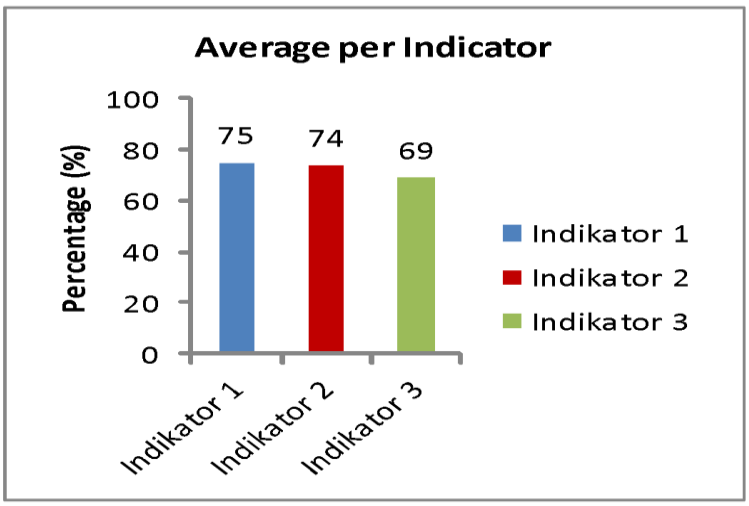

Figure 1. Average percentage of each Indicator

Figure 1 shows that there are differences shown in the three indicators used to determine the ability of students' science literacy epistemic knowledge on the material of colligative properties of solutions. The difference is shown by the percentage comparison on each indicator. Indicator 1 is explaining the process of scientific phenomena at an average percentage of 75% with a sufficient classification. Indicator 2 describes observations of scientific phenomena with an average percentage of 74% with sufficient classification. Indicator 3 concludes scientific phenomena with an average percentage of 69% with sufficient classification.

Explaining the process of phenomena scientifically

The first indicator, namely explaining the process of phenomena scientifically, includes one question, namely question number 4. Students are asked to be able to explain the process of phenomena scientifically. The question on this indicator provides an illustration related to scientific phenomena that occur in everyday life, most students answer by explaining the process of salt accumulation that causes pressure on blood volume to increase. Although the answer is almost correct overall, there are still a few parts that are not reviewed, namely the hydration of blood vessels due to the accumulation of salt which also affects the pumping of blood from the heart, so this question shows that students' scientific literacy skills are sufficient in explaining the process of scientific phenomena. The application of scientific knowledge and demonstrating scientific competence requires determination of which systems and boundaries are applied to specific contexts (O. Indicators, 2016).

This is in line with students' epistemic knowledge on the indicator of explaining the process of phenomena scientifically. So that the achievement of the first indicator, namely explaining the scientific process of phenomena, is 75% with a sufficient category.

Explain Observations of Scientific Phenomena

The second indicator describes observations of scientific phenomena including four questions, namely in questions number 1, 2, 5 and 6. Students are asked to be able to describe their observations of scientific phenomena. Questions on this indicator lead to images and data to be observed by students related to scientific phenomena that occur in everyday life, *most* students have been able to answer questions by describing as expected although there are still some students who tend to be a little out of the expected answers. Students have answered well by describing the initial process of boiling point then connected with the influence of electrolyte and non-electrolyte solutions so that the resulting substance particles can be ionised and affect the boiling point of the solution, good learning that can support science literacy is learning with Education through science (Utami, 2021).

In Education through Science learning, the science knowledge learnt is only the knowledge and concepts that are important to be able to understand socio-scientific issues in society. This indicates that when the lecture takes place, it has implemented Education through Science even though it is not directly but has been implied in the lecture. The average achievement in the second indicator of describing observations of scientific phenomena per question item was obtained 67% in question number 1, 81% in question number 2, 73% in question number 5, and 75% in question number 6. So that the total average achievement in this second indicator is 74% with a sufficient category.

Summarising Scientific Phenomena

The third indicator concludes scientific phenomena, this indicator includes one question, namely in question number 3. Students are asked to be able to conclude scientific phenomena, namely given an illustration of the phenomenon of scientific experiments that occur in everyday life, most students have been able to answer by concluding the results of the experiments carried out, but there are some students who tend to explain the process carried out on the illustration of the scientific phenomenon so that the answer is still incorrect because students are asked to conclude not by explaining the process that occurs. Students' science literacy skills can be improved by making an overview of the characteristics and potential of students, the development of learning materials, which must be adapted to the learning environment of students (Gormally et al., 2012). So that the achievement of the third indicator, namely concluding scientific phenomena, is 69% in the sufficient category.

Based on the results of the research data, to improve the science literacy of chemistry education students of FKIP Untan, it is necessary to improve the quality of classroom learning by changing methods or learning models that are more effective in order to improve the epistemic knowledge of science literacy that is sufficient to be even better. Learning models that can be used as active learning include case-based learning (problem-based learning). This case-based learning can be collaborated with contextual learning (concept) in order to direct students to understand the concept in the form of material applied to everyday life so that students can understand the concept of epistemic knowledge of science literacy better and can be an innovation to prevent the implications of the decline in epistemic knowledge of science literacy of students. Increasing the ability of epistemic knowledge of science literacy can be done through learning that emphasises problem solving skills that can be done with Problem-Based Learning (PBL) strategies (Sutrisna & Anhar, 2019) In line with that, PBL is also recommended as a learning cycle learning model in training science literacy skills (Trowbridge & Bybee, 1990) in (Adly Mohamed Ahmad Ibrahim Alnagar, 2007).

CONCLUSION

The results of the research on the ability of science literacy of chemistry education students of FKIP Untan shown based on the test of science literacy skills with epistemic knowledge of science literacy on indicators explaining the process of scientific phenomena with an average percentage of 75% with a sufficient category. Explaining observations of scientific phenomena with an average percentage of 74% with a sufficient category. Concluding scientific phenomena with an average percentage of 69% with a sufficient category. The overall total average of students' science literacy skills is 73.33% with a sufficient category.

RECOMMENDATIONS

Since the result of this study research, may in the next research explore the role of digital tools, such as augmented reality, and AI-driven learning platforms, in fostering scientific literacy. Investigating their effectiveness in different learning environments will provide valuable insights for students integrating technology into chemistry education.

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