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Submission date: 22-May-2023 08:57PM (UTC+0700)
Submission ID: 2099254050
File name: 1_Artikel_Usman_2023_AIP_Proceedings_Conference.pdf (474.09K)
Word count: 2533
Character count: 13964

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Cite as: AIP Conference Proceedings **2642**, 090007 (2023); https://doi.org/10.1063/5.0112941
Published Online: 11 January 2023

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Integration of Water Treatment Knowledge Using SETS Approach in Online Chemistry Learning to Improve Chemical Literacy of Students on the Aspect of Knowledge and Context

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Abstract. Chemical science literacy is one of the skills that students must master in the 21st century to solve their daily lives. One of the problems students face in the Delta Mahakam area is the difficulty of getting clean water. This study aims to determine the effect of integrating knowledge in water treatment technology using the SETS approach in online chemistry learning toward students' chemical literacy skills on knowledge and context. The research used the quasi-experimental method with a research design was the post-test only control group design. The populations in this study were all 10th-grade students in SMA Negeri 2 Muara Badak during the 2019/2020 academic year, with 53 students divided into two classes. The sampling technique used in this research was the saturated sampling technique. The instrument used to measure students' chemical literacy skills in knowledge and context was a post-test in the form of essay questions. The results showed that the experimental class's literacy ability score in knowledge and content was higher than the control class. The statistical analysis results using the t-test ($t_{count\ 2,134} > t_{table,\ 2,008}$; $\alpha=0.05$) indicates that the integration of water treatment technology using the SETS approach in online chemistry learning affected the chemical literacy skills aspects of knowledge and context. Therefore, the knowledge in water treatment technology using the SETS approach can be integrated with online chemistry learning to improve students' chemical literacy skills, especially in solving the problems of clean water availability in the Delta Mahakam area.

INTRODUCTION

Science literacy, especially chemical literacy, is one of the basic literacies students must master in the 21st century. In this century, students are required to meet their daily needs in various situations. Students who have good scientific literacy skills will understand science, communicate science, and apply scientific literacy skills to solve problems they face in real life [1]. The student with scientific literacy ability is expected to make correct decisions scientifically to improve the welfare of a more active and healthier life by overcoming actual problems in the student environment.

One of the problems currently being faced by people in the Delta Mahakam area in East Kalimantan Province is the problem of clean water availability. Most people living in this area still use groundwater as a water source to

1st International Seminar on Chemistry and Chemistry Education (1st ISCCE-2021)
AIP Conf. Proc. 2642, 090007-1–090007-5; https://doi.org/10.1063/5.0112941
Published by AIP Publishing. 978-0-7354-4304-4/$30.00

fulfill their daily needs for bathing, washing, and toilet because they did not get the facility of clean water installations from the local government yet [2]. The condition of groundwater used is still in the poor category because of yellow color and smells of rust. Knowledge of how to treat the water with a simple technology needs to be provided to the community to process groundwater into more feasible and healthier to use. This knowledge can be provided to high school students through its integration in chemistry because chemistry lessons are closely related to living things and the phenomena in the surrounding environment [3]. One of the materials studied by students in chemistry subjects that can be integrated with the water treatment knowledge is the oxidation-reduction (redox) reaction material. By using the redox concept, iron dissolved in groundwater will be oxidized to insoluble and eventually settles, and then it is easily separated by filtration [4].

SETS (Science, Environment, Technology, Society) approach is one of the approaches in learning that can be used to integrate water treatment knowledge in chemistry learning and link with environmental and community aspects in the Delta Mahakam Delta area. Through this approach, students have raised awareness of the relationship between elements of science, environment, technology, and society to apply the chemical concepts they have learned to produce valuable products for overcoming clean water problems in the surrounding community [5].

Due to the Covid-19 pandemic, all of the learning in the schools was conducted using an online learning system. This condition makes it difficult for most teachers to implement the SETS approach in online learning. Hence, in this present study, we evaluate the effectiveness of water treatment knowledge integration using the SETS approach in online chemistry learning to improve the students' chemical literacy skills on knowledge and context. Hopefully, this research will be an alternative solution in solving the clean water availability in the Delta Mahakam area from education.

METHODS

This study used a quasi-experimental research method with the research design being a posttest-only control group design (Table 1). The dependent variable was the integration of water treatment knowledge using the SETS approach, and the independent variable was the chemical literacy on the aspect knowledge and content. The population in this study was all of the 10th-grade science students at SMAN 2 Muara Badak, Kutai Kartanegara, Indonesia, in the 2019/2020 academic year, amounting to 2 classes that were subsequently assigned into experimental and control groups using a saturated sampling technique. Each class has a relatively homogeneous condition based on the homogeneity test of the variance and t-test. The experimental group was taught by direct learning models using the SETS approach to integrating water treatment knowledge into the redox concept in online chemistry learning (X). In contrast, the control group was taught by direct learning method using a conventional approach without integrating water treatment knowledge into the redox concept in online chemistry learning. After the learning process, all students in both groups were given a post-test (O).

TABLE 1. Design of post-test control group.

	Treatment	Post-Test
Experiment group	X	O
Control group	-	O

O: post-test; X: treatment

TABLE 2. The indicators to measure the chemical literacy.

Domain	Aspects	No.	Question Indicators
Knowledge	Content	1	Students can use the key concepts needed to understand natural phenomena and their changes to nature through human activities.
	Procedural	2	Students can use standard procedures that underlie the methods and various practices used.
	Epistemic	3	Students can propose a hypothesis on the experimental design being carried out.
Context	Health and disease	4	Health care, accidents, and nutrition.
	Environmental quality	5	Population distribution, impact of waste disposal to environment.

The data in this research were collected using the test instrument in an essay to measure the students' chemical literacy consisting of knowledge and context aspects. The test instrument consists of five questions related to the concept of redox material. Before being used, the test instrument was validated by material experts, and all items were declared valid. The indicators used in measuring students' chemical literacy skills can be seen in Table 2.

The post-test data were tested for normality and homogeneity as a prerequisite for determining the statistical analysis. The normality test was conducted using the Kolmogorov-Smirnov test with α=0.05. The t-test was conducted to determine the significantly different meanings between the two classes with significance level used was α=0.05 and assisted by SPSS 16 program. Quantitative data of the chemical literacy of students were then converted into qualitative data referring to the following criteria (Table 3).

TABLE 3. The category of students' chemical literacy [6].

Score	Category
0–20	Very less
21–40	Less
41–60	Enough
61–80	Good
81–100	Excellence

RESULTS AND DISCUSSION

In this study, we measured students' chemical literacy skills using a chemical literacy test instrument which is consisted of knowledge and context aspects. Table 4 presents the data of students' chemical literacy abilities measured after treatment.

TABLE 4. Data of students' chemical literacy.

Domain	Aspects	Control Class	Category	Experimental Class	Category
Knowledge	Content	57.86 ± 3.74	Enough	76.00 ± 4.50	Good
	Procedural	43.00 ± 2.91	Enough	69.60 ± 6.17	Good
	Epistemic	43.39 ± 6.69	Enough	68.20 ± 7.42	Good
	Mean score	48.08 ± 20.50	Enough	71.27 ± 22.45	Good
Context	Health and disease	38.57 ± 1.56	Less	70.60 ± 5.18	Good
	Environmental quality	50.89 ± 4.85	Enough	61.60 ± 3.97	Good
	Mean score	44.73 ± 21.75	Enough	66.10 ± 21.08	Good
	Total mean score	46.74 ± 13.11	Enough	69.20 ± 18.27	Good

Based on data, the chemical literacy of students both in the aspect of knowledge and context for the experimental class was higher than those for the control class. The result of statistical analysis as presented in Table 5 showed that there is a significant difference in the students' chemical literacy between the experimental class and the control class ($t_{stat,\ 2.134} > t_{table,\ 2.008}$; P<0.5), indicating that integration of knowledge about water treatment technology using the SETS approach in online chemistry learning can improve chemical literacy skills in the aspects of knowledge and context.

TABLE 5. Statistical analysis of the students' chemical literacy skills.

Groups	Mean Score	Category	F_{count}	F_{table}	t_{stat}	t_{table}
Control	46.74	Enough	0.518	1.054	2.134	2.008
Experiment	69.20	Good				

This result follows two previous findings [7-8] that learning using the SETS approach effectively improves the students' scientific literacy skills. In the present study, students in the experimental class were given learning material about applying redox in iron-rich groundwater into clean water with low iron content. This learning material context is a contextual problem relating to the conditions faced by students living in the Muara Badak district. Contextual learning gives students direct experience that can increase their potential to seek and apply the chemistry concepts they are learning [9]. This contextual problem will make students feel meaningful learning. Sinaga and Silaban [10] stated that students would respond positively if given the learning topic according to their daily experiences to feel interesting and enthusiastic learning. In implementing the SETS approach, the actual problem about the clean water problem in the Delta Mahakam area was given at the invitation stage. Giving the problem at this stage allows the students to feel more contextual in learning chemistry to solve the problems related to the literacy aspect of content knowledge.

Meanwhile, students in the control class were given learning material about the browning in fruit as usual used by the teacher. The learning material given in the control class is common knowledge and often found in several textbooks. Explanations to solve the problem given in the experimental class are related to the previous learning material which the student has studied. In contrast, the problem given in the control class is challenging to understand because it needs hydrocarbon knowledge to explain what was not studied yet by students.

Learning with the SETS approach in the experimental class used the reading material in scientific articles containing water treatment knowledge. Leopold *et al.* [11] revealed that the use of scientific reading materials could increase the imagination power of students, so it can help students solve and reason the problem. As a result, students in the experimental class can use the chemistry concept to answer the literacy question, especially in knowledge. In the exploration and solution stages, students in the experimental class can understand the problem given in the invitation stage, and they were trained to make a procedure design in solving the problem. Students can learn the additional material through another literature study in this stage. Integration of knowledge about water treatment technology in online chemistry learning was conducted using learning videos given in the exploration and solution stages. This video was able to assist the student in making the design of the water treatment apparatus. This finding follows Brame [12], stating that a learning video could help students understand a procedural. Learning video can provide simultaneous stimulation and help students understand the concept [13]. SETS approach can increase the chemical literacy skill in the aspect of knowledge because this approach provides learning based on phenomenon allowing students to understand the material. Students in the experimental class can also use the chemistry concepts about Redox Reaction to answer the chemical literacy question in a health and disease context. Another report explained that the SETS approach could train the students' critical thinking skills [14]. This finding aligns with what was reported that the SETS approach effectively improves students' scientific literacy [15-16].

CONCLUSION

Based on the analysis and interpretation of the research results, we concluded that the integration of knowledge about water treatment using the SETS approach in online chemistry learning was effective in improving students' chemical literacy skills. However, for further research, we need to evaluate the integration of knowledge about water treatment using other learning approaches both in online or offline systems to improve the chemical literacy skill to provide a comprehensive alternative learning strategy to solve the problem relating to clean water availability.

ACKNOWLEDGMENTS

We thank Dr. Farah Erika and Ratna Kusumawardhani, M.Pd. for the corrections and suggestions in this research.

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