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Fostering Environmental Knowledge and Literacy with Natural Products Experiment Activity Worksheets

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Abstract

This research aims to improve student environmental knowledge and literacy with natural products experiment activity worksheets. The methods used in this research are pre-experimental. The subjects of this research are 15 students from an Islamic high school. The research results show that natural products experiment activity worksheets effectively improve students' learning outcomes. The research results indicate that the pre-test results obtained an average score of 50.8, indicating that students needed help understanding the material before using natural products' experiment activity worksheets. Post-test results showed an average score of 80.5, indicating that students experienced increased learning outcome scores. The average normalized gain score is 0.59, indicating a medium increase in chemistry learning outcomes. The self-assessment questionnaire on environmental literacy, conducted after using the integrated natural products experiment activity worksheets, showed that knowledge had an average score of 4.33 and was rated as excellent, behavior had an average score of 4.31 and was rated as good, and attitude had an average score of 4.37 and was also rated as good. Overall, students' environmental literacy was rated as outstanding, with an average score of 86.74%.

Keywords: experiment activity worksheets, environmental knowledge, environmental literacy, natural products

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1. Introduction

Chemistry is one of the important and beneficial subjects in our daily lives (Choiriyah, 2015). According to (Allamin & Yonata, 2016), the science of chemistry studies everything about matter: its composition, structure and properties, changes, dynamics, energy, and others that require skills and reasoning.

Learning is currently being developed to be student-centered (Gover et al., 2019), which involves student activity and directs students to explore their potential (Khotim et al., 2015; Lee et al., 2016). However, the implementation of science learning, including chemistry, in high school still needs to pay more attention to students' achievement of understanding and activities. Based on the results of observations at the MAN Semarang school, fifteen samples of students were taken to take the pretest, and low scores were obtained, so students still needed help understanding abstract chemical material. This is because students are required to imagine its existence without actually experiencing it. Therefore, to help students study chemistry, one approach can be taken through practical activities. Experiment activities can provide direct experience due to meaningful learning

(Domínguez et al., 2013; Andromeda et al., 2016).

Chemistry is integral to modern chemical education (Hyde, 2024). Almost all middle/high schools have libraries and multimedia equipment where students can use these facilities to learn more about chemistry than just textbooks (King, 2912; Stieff, 2019). Laboratories play an important role in chemistry learning because they make it possible to understand abstract concepts and quickly translate them into concrete ones. Laboratory learning increases students' interest and skills in science subjects. It develops students' cognitive, emotional, and psychomotor aspects in achieving practicum objectives, as supported by the opinion (Christianto & Azmi, 2014) that most students obtain higher psychomotor scores than cognitive scores through practicum activities. This shows that students understand chemistry subjects better through practical activities.

Chemistry learning is a learning process that involves students' role in understanding a chemical concept. Chemistry learning results will only be optimal if practical activities do not accompany it. However, the reality in the field shows that the management of chemistry practicum facilities and infrastructure needs to be appropriately implemented. Some schools find it challenging to carry out teaching activities in the form of practicums, and their implementation is often omitted due to the unavailability of tools and materials that support the implementation of chemistry practicums.

One of the reasons why practicum subjects cannot be implemented in high schools at this time is the limited practicum instructions that can provide solutions to environmental problems. Awareness of caring for the environment is related to an individual's ability to understand the environment where they consciously try to protect the environment, determine appropriate actions to overcome it and offer solutions to environmental problems, known as environmental literacy (Kusumaningrum, 2018; Otto & Pensini, 2017). Environmental literacy is understanding everything related to the environment, including knowledge about existing problems and the ability to find solutions to overcome environmental problems (Hadi et al., 2020). According to (Wardani et al., 2018), a person's behavior and sensitivity to the environment indirectly reflect their environmental literacy so that it can influence environmental sustainability, development and sustainable use of natural resources. Aspects of environmental literacy that students possess will demonstrate behavior that acts responsibly towards the environment through knowledge, skills and awareness of environmental issues (Febriasari & Supriatna, 2017).

One learning tool that can be developed to overcome the above problem is a natural products experiment activity worksheets to increase students' knowledge of chemistry at school. Experiment activity worksheets are a learning tool that also has a vital role in the learning process so that it is achieved well (Prastowo, 2015). Experiment activity worksheets are sheets of material, summaries, and instructions in the form of steps to complete tasks that must be carried out (Amali & Leman, 2019). Experiment activity worksheets functions to increase and deepen students' knowledge regarding the material provided because, in experiment activity worksheets, there are components that have been formed to provide motivation or attraction in the form of problems related to daily activities (Lestari & Muchlis, 2021).

Experiment activity worksheets oriented to the potential of natural product is laboratory instructions suggest that expensive or hard-to-find chemical materials can be replaced with natural substances readily available in our surroundings or everyday life (Lutfauziah et al., 2023). The surrounding natural environment can be used as a source of practical materials because it still has good utilization potential. Using natural product in chemistry practicum at school can overcome the problem of equipment and materials that are expensive or not available in the laboratory. Utilizing the environment as a source of practical material

will trigger and spur efforts to develop an environmental literacy attitude.

Based on the results of an interview conducted on September 2 2021, with Mr. Nuryanto, S.Pd. as chair of the Semarang City Chemistry teacher's consortium, the students' experiment activity worksheets used by teachers are taken from supporting books or student's worksheet, and sometimes teachers make their own students' experiment activity worksheets. However, the activity worksheets only consist of questions that students work on in the assignment book. Such experiment activity worksheets could be more exciting and interactive. Students must be tuned to receive feedback and scores quickly regarding the students experiment activity worksheets they are working on. This makes students lose enthusiasm for learning and impacts students' knowledge competencies, which could be more satisfactory, one of which is the science content (Schmidt & Lee, 2019).

Students' experiment activity worksheets are a learning activity guide that determines student learning outcomes, so at least it must be interactive and improve learning outcomes. Interactive students' experiment activity worksheets at least carry out practicum activities at school. Apart from learning outcomes, environmental literacy attitudes can also be formed using the potential of the natural environment as practicum material at school. The chemistry practicum is a practicum in learning that uses natural product.

This research aims to improve student environmental knowledge and literacy assisted students' experiment activity worksheets oriented to the potential of natural product.

2. Research Method

The methods used in this research is pre-experimental using pretest-posttest group design. Pre-experimental design aims to establish a cause-and-effect relationship between an independent and dependent variable (Hunziker et al., 2021). However, unlike a true experiment, a pre-experimental does not rely on random assignment (Croucher & Cronn-Mills, 2022). Instead, subjects are assigned to groups based on non-random criteria (Kennedy et al., 2019).

Before the implementation of the research, training and development of students' experiment activity worksheets oriented to the potential of natural products were conducted with 18 teacher the member of Semarang City chemistry teacher consortium. The implementation of the developed student laboratory worksheets was carried out in a senior high school by one of the teachers who had participated in the training. The chemistry students' experiment activity worksheets format is the title, background, problem formulation, practicum objectives, theoretical basis, tools and materials, work methods, observation data, data analysis, assignments, and understanding tests.

The data of this research taken from 15 students were from MAN 2 Semarang, an Islamic high school in Semarang City, Central Java, Indonesia. The increase in student knowledge was analyzed using Hake's normalized N-gain formula, as in formula 1 (Asyhari, 2015; Sesmiyanti et al., 2019).

$$N - Gain = \frac{postest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad (1)$$

Table 1. Gain Score Criteria (Nisaâ et al., 2015)

Interval	Criteria
G ≥ 0,7	Hight
0,3 ≤ g ≥ 0,7	Medium
G < 0,3	Low

The instruments used for data collection were test questions and questionnaires. The test questions and questionnaires are arranged according to environmental literacy indicators, as shown in Table 2. An interval of more than 0.7 is a high criterion, an interval between 0.3 and 0.7 is a medium criterion, and an interval below 0.3 is a low criterion, as in Table 1. Calculations using the N gain formula show that the increase in student knowledge results from pretest to posttest scores.

Table 2. Environmental Literacy Indicators

Environmental Literacy Indicators	Sub Environmental Literacy Indicators
Knowledge	Deforestation knowledge
	Climate change knowledge
	Global warming knowledge
Behavior	Commitment to environmental care
Attitude	Commitment to herbal products
	Environmental sensitivity

The questionnaire sheet to assess environmental literacy on the indicators of knowledge, attitudes, and behaviors towards the environment consists of 24 statements that need to be answered on a Likert scale. The research data is then analyzed descriptively based on the scoring criteria for each environmental literacy indicator (EL). The results of the students' environmental literacy test on the knowledge indicator are analyzed using formula 2.

$$\% \text{ EL} = \frac{\sum respondent\ answer\ score}{score\ \max \times \sum question \times \sum respondent} \quad (2)$$

Then, these results are converted to environmental literacy criteria, as in Table 3.

Table 3. Criteria for environmental literacy percentage (Riduwan, 2014)

Percentage	Criteria
1-20	Very poor
21-40	Not good
41-60	Fairly good
61-80	Good
81-100	Very good

3. Result and Discussion

Before being used, the practical worksheet for students oriented towards natural products developed by the Semarang City Chemistry Teacher Consortium was first validated by the lecturer, who served as a reviewer and validator. The Chemistry Students' Practical Activity Worksheets format is the title, background, problem formulation, practicum objectives, theoretical basis, tools and materials, work methods, observation data, data analysis, assignments, and understanding tests. The characteristics of the environmental literacy on experiment activity worksheets developed are practical activities using natural products Ingredients that can be found in our daily life environment.

Figure 1. Cover of natural products experiment activity worksheets

Environmental literacy studies contained in the students' worksheet include the selection of natural ingredients such as turmeric, ginger, secang wood, and palm sugar (in the reaction rate material) to measure the effect of temperature on the rate of spice extraction, the effect of surface area on the rate of spice extraction, the effect of concentration on the rate of spice extraction. Cover and procedure of natural products experiment activity worksheets can be seen in Figure 1 and Figure 2.

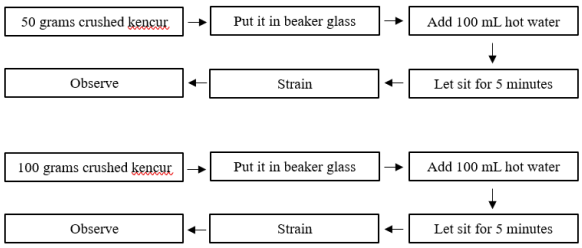

Figure 2. Procedure for the effect of concentration on the extraction rate of kencur

3.1 Environmental Knowledge

The better learning achievement of students is one of the factors of educational success. Increased knowledge can be used to identify student learning achievements. According to Notoatmodjo (2003), knowledge results from humans answering the question "What." Knowledge is the result of knowing after sensing something. Sensing occurs through the five human senses responsible for sensing: smell, taste, hearing, sight, and touch.

Table 4. Pretest and posttest results after using natural products experiment activity worksheets

No	Pretest Score	Posttest Score	N-Gain	Category
1	33	67	0,51	Medium
2	33	83	0,75	High
3	33	75	0,63	Medium
4	42	83	0,71	High
5	42	83	0,71	High
6	33	67	0,51	Medium
7	42	83	0,71	High
8	42	75	0,57	Medium
9	58	83	0,60	Medium
10	42	75	0,57	Medium
11	60	80	0,50	Medium
12	71	88	0,59	Medium
13	75	89	0,56	Medium
14	77	88	0,48	Medium
15	79	89	0,48	Medium
Mean	50,8	80,5	0,59	Medium

According to Kholid (2012), a person's level of knowledge in detail consists of six levels, namely: 1) Know is defined as remembering material that has been studied previously. 2) Comprehension is the ability to explain known objects and interpret the material correctly. 3) Application is the ability to use a material studied in actual situations or conditions, namely formulas, methods, principles, and so on, in other situations. 4) Analysis is the ability to describe material or an object within the organizational structure and how it relates to each other. 5) Synthesis shows a person's ability to summarize or relate the components of their knowledge in a logical way. 6) Evaluation is related to a person's ability to justify or assess an object. Pretest and posttest results after using natural products experiment activity worksheets can be seen in Table 4.

Before the practicum begins by adhering to the students' experiment activity sheets that have been developed, a pretest is carried out first to determine the student's initial abilities regarding the material that will be carried out in the practicum. Based on the table, the pretest results obtained an average of 50.8, and it can be seen that students do not understand the material that will be practised before using the students' experiment activity worksheets.

After carrying out the practicum using the students' experiment activity worksheets, a post-test was conducted to determine the increase in student knowledge regarding the material being practised. The post-test results obtained an average score of 80.5; this proved that students experienced an increase in knowledge scores after using the students' experiment activity worksheets that had been created. By calculating the accumulation of standard gain values using the normalized N gain formula, students' knowledge of research is increased. The recapitulation results of the N-gain calculation of knowledge value with the help of students' experiment activity worksheets are presented in Figure 3.

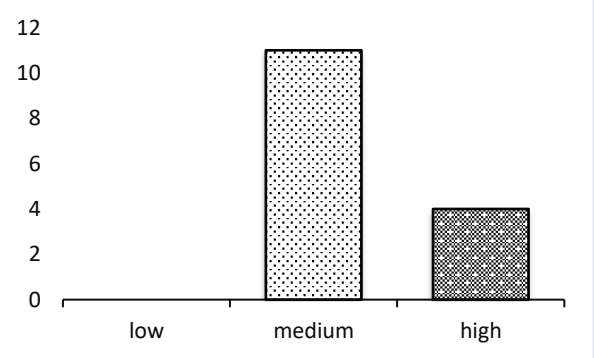

Figure 3. Results of N-gain knowledge value

Based on the Figure 3, the N-gain recapitulation results, it can be seen that there is an increase in student knowledge results from pretest to post test scores. The analysis showed that four students experienced a high increase in learning outcomes, 11 students experienced a moderate increase, and no

students experienced a low increase in learning outcomes. The overall average value of N-Gain is 0.59, and the increase in chemistry learning outcomes is in the medium category.

Chemistry learning using environmental literacy-oriented students' experiment activity worksheets has proven effective in increasing students' knowledge. This is by research conducted by Herawati et al. (2024), who developed integrated environmental literacy students' experiment activity worksheets. The research showed that students' experiment activity worksheets oriented to the potential of natural chemicals, effectively increased students' knowledge with an average N-gain value of 0.62 in the medium category. Other research was conducted by Sya'idah et al. (2020) and Lin (2017), who developed electronic where the learning outcomes of the experimental class were better than those of the control class, as indicated by the percentage of students achieving perfect criteria reaching 88.89% in the experimental class and 80. 56% in the control class. Salwan & Rahmatan (2017) in their research also stated that discovery learning-based students worksheet saw an increase in learning outcomes in the experimental class with an N-Gain of 0.36% (medium category), while in the control class, it was 0.07% (low category).

3.2 Environmental Literacy

According to Hollweg et al (2011), environmental literacy is knowledge that includes environmental concepts, the application of science to make good decisions in the surrounding environment, issues, attitude disposition, motivation, cognitive abilities, skills, self-confidence, and appropriate behavior in solving environmental problems. According to Nasution (2021), environmental literacy includes knowledge about the environment; it also consists of how to behave, be responsible, care for, and be aware of the environment's existence. Increasing environmental literacy aims to prepare the young generation to act and have a positive attitude towards the environment (Sinaga, 2019).

Several components can be used to measure a person's environmental literacy abilities. These components include students' knowledge about the environment, skills, character, and behavior of students towards the environment (Afrianda et al., 2019). This has been supported by the NAAEE, which states that a person's environmental literacy status can be measured based on the criteria of environmental literacy components, namely knowledge, skills, character (disposition), and environmentally responsible behavior (Environmentally Responsible Behavior) (Hollweg et al., 2011). The data obtained in this research is descriptive in the form of percentages. This quantitative data is in the form of students' answers when filling out the environmental literacy questionnaire that was developed. Assessments are given using a Likert scale with four statements. The environmental literacy questionnaire has three sections consisting of six knowledge questions, nine behavior questions, and nine environmental literacy attitude questions. The results of the environmental literacy pretest and posttest can be seen in Table 5.

Table 5. Environmental Literacy Pretest and Post test Results

Literacy indicators	Pretest	Posttest	Category
Knowledge	3,8	4,33	Good
Behaviour	3,6	4.31	Good
Attitude	3,8	4,37	Good

Based on the average data from the self-assessment questionnaire, it shows that after using the students' experiment activity worksheets, integrated environmental literacy in the knowledge aspect is categorized as good with an average of 4.33, behavior is categorized as good with an average of 4.31 and attitude is categorized as good with an average of 4. .37 by the environmental literacy component assessment criteria. The percentage results of students' environmental literacy analysis for each indicator can be seen in Figure 4.

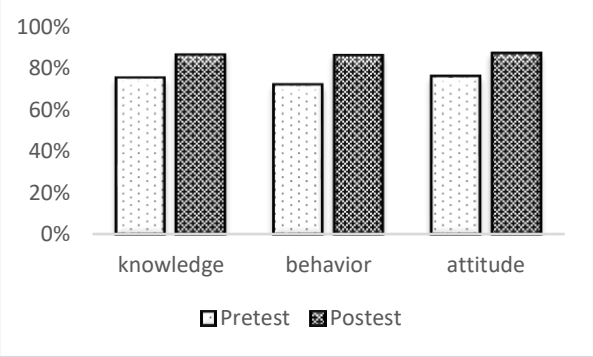

Figure 4. Average Percentage of Environmental Literacy Indicators

Based on Figure 4, there has been an increase in the average percentage of each environmental literacy indicator. This increase can be seen from the increase in the average percentage obtained in the posttest, which is higher than the pretest. The indicator with the highest increase is the behavioral indicator towards the environment; this is because the integrated environmental students' experiment activity worksheets content developed contains several articles regarding problems and questions that can provoke students to come up with ideas in planning what actions they can take regarding environmental problems in their environment, around them. (Ardoin et al., 2018; Kinslow et al., 2019; Suryawati et al., 2020).

Based on the analysis of the results of filling out the environmental self-assessment questionnaire, the overall average in the outstanding category is 86.74%. These results can be achieved because there is a match between students' attitudes and behaviour in everyday life.

Chemistry learning using environmentally integrated students' experiment activity worksheets can motivate students to be aware of the environment around them. This is also to the results of research conducted by Awang & Zakaria (2012) and Kingsley & Grabner-Hagen, (2015), which states that learning using modules with real-life examples in students' environments can develop literacy, including environmental literacy and help students improve their conceptual and procedural mastery abilities. What they just learned. Ilma & Wijarini (2017) and Martin & Bolliger, (2018) also stated that learning that uses environmentally based teaching materials by linking it to the local potential of an area can help students understand environmental concepts and help students understand existing local potential, and help students better understand the concepts that will be taught. Research conducted by (Ilhami et al., 2019) states that applying science learning with a local wisdom approach can help students strengthen the scientific concepts they have acquired so that students' environmental literacy abilities also increase.

4. Conclusion

Based on the results and discussion, it can be concluded that the natural products experiment activity worksheets obtained a pretest result of 50.8, meaning that students needed help understanding the material before using the student worksheet. After using the students' experiment activity worksheets, the post-test results showed an average score of 80.5, indicating that students experienced increased learning outcome scores. The average normalized gain score is 0.59, and the mean increase in chemistry learning outcomes is in the medium category. Meanwhile, the environmental literacy results based on the self-assessment questionnaire after using the environmental literacy integrated students' experiment activity worksheets in the knowledge aspect were in the excellent category with an average of 4.33, behavior in the good category with an average of 4.31, and attitude in the excellent category with an average of 4.37 by environmental literacy component assessment criteria and the overall average of students' environmental literacy is in the outstanding category with a percentage of 86.74%.

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