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Application of Science Process Skills-Based Worksheets On The Project of Making Natural Larvicide From Areca Nut

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Abstract
This study aims to describe the application of science process skills-based worksheets in the project of making larvicides from areca nut extract on the cognitive and psychomotor aspects of students, as well as to determine the effectiveness of areca nut extract as a larvicide. This research raised the issue of using synthetic larvicides as learning facilitated by science process skills-based worksheets. The larvicide was divided into six concentration variations. This study used a pre-experiment method with a one-shot study case design involving one experimental class, without a pretest or control class. The subjects used in this study were 36 10th grade students of MAN 2 Bandung City. Data collection used instruments in the form of science process skills-based worksheets, observation sheets, performance assessment sheets, and presentation assessment sheets. Data analysis of science process skills was done with a Likert scale assessment. The cognitive aspect of the science process skills worksheet obtained an average score of 82, with a very good interpretation, while the psychomotor aspect of students was 83, which showed a very good interpretation. It can be concluded that the use of science process skills-based worksheets can help in cognitive skills and psychomotor skills. In the larvicide making project, effective results were obtained at a concentration of 9 mL with a percentage of mosquito larvae death of 100%.

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INTRODUCTION

Mosquitoes are one of the insects that can act as disease vectors for humans. Malaria, dengue hemorrhagic fever (DHF), malaria, jaundice, zika, Chikungunya, Japanese encephalitis, and filariasis are some examples of diseases that mosquitoes can spread to humans. (Windyaraini et al., 2020). The vector mosquito population must be controlled to prevent the spread of the disease. The use of larvicides to stop the metamorphosis of disease vectors is one way to control disease vector populations. (Widyastuti et al., 2019).

Larvicides are a type of pesticide that can kill larvae or eradicate insects before they become adults. (Ainun et al., 2024). Temephos is a very commonly used synthetic larvicide, but it has some disadvantages (Ali, 2020). The disadvantages are that it can lead to resistance in mosquitoes due to its transovarial nature, and can have negative impacts on human health, such as poisoning if ingested. (Noya et al., 2022). The harmful side effects of synthetic larvicides, such as resistance in mosquitoes and toxicity in humans, have prompted the development of natural larvicides (Karima & Ardiansyah, 2021). Natural larvicides have several advantages over synthetic larvicides, namely higher safety levels and environmental friendliness. This is because natural larvicides have low toxicity to mammals, so they do not cause harmful effects on human health (Maula & Musfirah, 2022).

Environmental issues can be used as learning opportunities for students to actively address these issues (OECD, 2022). Students must be heavily involved in learning to improve their understanding and problem-solving skills, which contributes to their growth. Worksheets enable more active interaction between students and learning materials; this allows students to understand abstract concepts visually and practically (Sari & Firman, 2023).

Worksheets help practical learning activities to be carried out effectively and efficiently (Rahmatullah & Fadilah, 2017). Worksheets can be used in several learning models, two of which are practical learning and project-based learning (Sari et al., 2020). In practical learning, worksheets can be used by students as a reference in acquiring practical skills with a good understanding of interrelated concepts (Fatmawati et al., 2022).

Chemistry learning with practical work can improve students' ability to discover concepts independently and solve problems (Ratnawati & Praptomo, 2023). Students' scientific process skills will also be further honed during the experiment. Scientific process skills consist of basic and integrated process skills. Basic process skills include observing, measuring, predicting, classifying, and communicating. Integrated process skills include identifying problems, forming hypotheses, planning experiments, interpreting data, and drawing conclusions (Fatmawati et al., 2022).

Science process skills serve as a medium to further analyze our natural world through scientific observation and exploration (Alatas & Fachrunisa, 2019). By using process skills in learning, students can engage directly with the subject matter (Yuniasih et al., 2022). This enables them to think more critically, become more adept at asking questions, and learn to use scientific methods (Gizaw & Sota, 2023). All of this will result in better quality education and educational products, as well as better learning outcomes for students. The concept of chemistry material not only covers theory but also requires practical activities to explain concepts that require concrete evidence (Choirunnisa et al., 2018).

The student worksheets themselves are very helpful for students to solve various kinds of problems because the student worksheets used contain many practice problems, but have not been able to help students understand the concepts and for experiments that do not show science process skills and critical thinking because the student worksheets used only contain various kinds of questions for assignments (Sahara et al., 2021). For experimental activities there is no column or command to plan experiments such as writing down the tools and materials used and the experimental procedures carried out. So that students cannot develop their scientific attitude (Saragih et al., 2022). Based on the above statement, science process skill-based worksheets are suitable for application in situations related to environmental issues, one of which is the case of water pollution due to the use of synthetic larvicides.

In previous studies, research has been conducted on analyzing the effectiveness of areca nut extract larvicides, from these studies it was found that the effective concentrations used against larvae were in the range of 200 to 2700 mg/L of areca nut extract without any toxic effects on non-target organisms (Bharathithasan et al., 2021). In addition, Ali (2020) research divided the concentration testing of areca nut extract into 4 concentrations, namely 2000 ppm, 3000 ppm, 4000 ppm, and 5000 ppm. Based on this study, the average percentage of larval mortality was 39.2% at a concentration of 2000 ppm, 72% at a concentration of 3000 ppm, 84.8% at a concentration of 4000 ppm, and 100% at a concentration of 5000 ppm.

According to WHO in research of Noya (2022) the percentage of larval mortality of 95% is said to be effective. In some previous studies there has been no application in worksheets to students. So that researchers want to apply science process skills-based worksheets to the practicum of making areca nut extract with concentration variations of 5 mL, 6 mL, 7 mL, 8 mL, 9 mL, and 10 mL, each of which is dissolved in one liter of distilled water. This is so that

knowledge related to the manufacture of natural larvicides can be realized to students as knowledge that can be applied in everyday life.

Based on this, practical work on natural larvicides needs to be done because it is one of the applications of natural materials in reducing environmental pollution, one of which is water pollution. The practicum work process will be assisted by worksheets that can guide students in completing a project. The use of conventional worksheets that are less effective in developing the attitude of science process skills thus encouraging researchers to apply worksheets based on science process skills, besides the adverse effects of using synthetic larvicides as a problem that can be developed as learning to encourage students' critical thinking attitudes. Based on the description above, this study aims to describe the worksheet based on students' science process skills in the project of making larvicide from areca nut extract and identify the effectiveness of areca nut as a natural larvicide.

METHOD

The research method was a pre-experiment based on a one-shot case study design. This method is one of several systems that can be studied by researchers. In this design, there is a group that is given treatment, and then the results are observed (treatment is the independent variable, and the results are the dependent variable) (Sugiyono, 2021). This study only involved one experimental class, namely 36 10th grade students of MAN 2 Bandung City in Chemistry subjects, without any pre-test or control class. This study focuses on the effectiveness of the application of worksheets on student learning outcomes, so it uses a one-shot case study design.

Translated with DeepL.com (free version) The research activity was divided into three stages: the initial stage, the implementation stage, and the final stage (Prahmana, 2017). The initial stage included preliminary studies of relevant journals, analysis of materials, namely larvicides as products, and analysis of worksheets based on scientific process skills and literature studies. Next, preliminary tests are conducted, followed by the development of research instruments.

The research instruments include learning descriptions, worksheets based on scientific process skills, observation sheets evaluated by observers, performance assessment sheets, and presentation assessment sheets. Subsequently, the research instruments will be validated by education experts, subject matter experts, and teachers. Instrument validation results was calculated as a percentage score distribution to ensure the suitability level of the instruments in terms of language, construction, and content, using the formula.

$$Percentage = \frac{Number\ of\ points\ obtained}{Maximum\ number\ of\ points} \times 100\%$$

The percentage results of the instrument feasibility can be categorized based on Table

Table 1. Criteria for Expert Validation Percentage Analysis (Arikunto, 2013)

Percentage of Feasibility (%)	Category
75 – 100	Highly feasible
50 – 75	Feasible
25 – 50	Not feasible
0 – 25	Highly not feasible

The feasibility percentage values of the research instruments from three expert validators are shown in Table 2. During the implementation stage, learning was carried out in accordance with the learning description syntax based on scientific process skills. Researchers filled out observation sheets on all student activities during the practicum process. After that, students collected worksheets and reported data in the form of practicum reports and presented the

results of the experiment regarding the experiments that have been conducted. The final stage is to compile a final research report that includes data processing, data analysis, and drawing conclusions from the application of worksheets based on scientific process skills, so that results can be obtained.

Table 2. Results of instrument validation

Validated Aspects	Validator I	Validator II	Validator III	Aspect Average
Completeness of presentation	80%	90%	80%	83%
Content construct	80%	80%	70%	77%
Appropriate display	100%	80%	80%	87%
Science Process Skills Assessment	90%	93%	80%	88%
Language readability	90%	80%	80%	85%
Validator Average	88%	85%	78%	84%
Category	Highly feasible	Highly feasible	Highly feasible	Highly feasible

Data analysis of science process skills was conducted by assigning scores based on the Likert scale. The Likert scale is a psychometric tool designed to measure attitudes in a scientifically validated manner. It consists of a set of statements (items) related to a real or hypothetical situation under study. Participants indicate their level of agreement with these statements on a metric scale, typically ranging from "strongly disagree" to "strongly agree." The combination of responses to these items reveals specific dimensions of the attitude being measured, making the items necessarily interlinked (Joshi et al., 2015). The data was analyzed using a seven/ten point Likert scale with five rating points: 1 (Very poor), 2 (Poor), 3 (Neutral), 4 (Good), and 5 (Very good) (Joshi et al., 2015). Subsequently, quantitative calculations were performed using the formula:

$$Score = \frac{Number\ of\ points\ obtained}{Maximum\ number\ of\ points} \times 100$$

Once the scores are obtained, they are interpreted using a scale to assess student ability as listed in Table 3.

Table 3. Student grade interpretations (Sugiyono, 2021)

Average	Interpretation
80 – 100	Very Good
66 – 79	Good
56 – 65	Neutral
40 – 55	Poor
0 – 39	Very Poor

RESULTS AND DISCUSSION

Based on the results of the research conducted, data was obtained regarding the results of student activities in completing worksheets based on scientific process skills in making natural larvicides from areca nut extract. The results of the observations made by observers during the implementation of science process skills-based learning can be seen in Table 4, which shows the results when students completed each stage of learning about making natural larvicides from areca nut extract. The observation sheet consists of learning stages that include several points in accordance with the interpretation observed.

Based on Table 4, the science process skill indicator for analyzing problems obtained an average score of 91, which is classified as very good. The indicator for asking questions

obtained a score of 80, which is classified as very good, while the indicator for formulating hypotheses obtained a score of 77, which is classified as good. The indicator for planning experiments has an average score of 77, categorized as good, while the indicator for using tools and materials is interpreted as very good with a score of 84.

Table 4. Results of student cognitive assessment

Science Process Skills Indicators	Average	Standard Deviation	Interpretation
Analyzing the problem	91	5.41163	Very Good
Asking questions	80	6.54926	Very Good
Formulating hypotheses	77	11.41803	Good
Planning an experiment	77	11.54371	Good
Using tools and materials	84	9.95418	Very Good
Interpreting and applying concepts	86	4.23927	Very Good
Communicate	83	5.27528	Very Good

The indicator for interpreting and applying concepts has a score of 86, interpreted as very good, and the indicator for communicating is interpreted as very good with a score of 83. Overall, the results of the analysis of students' science process skills in the cognitive aspect showed an average score of 82 with a very good interpretation.

Table 5. Results of students' psychomotor assessment

Science Process Skills Indicators	Average	Standard Deviation	Interpretation
Analyzing the problem	92	3.77964	Very Good
Asking questions	78	12.30563	Good
Formulating hypotheses	75	16.30074	Good
Planning an experiment	77	21.64651	Good
Using tools and materials	83	1.72378	Very Good
Interpreting and applying concepts	90	10.14185	Very Good
Communicate	87	3.36367	Very Good

Table 5 shows the psychomotor aspect scores for the science process skill indicators. The average score for analyzing problems was 92, which is classified as very good, while the average score for asking questions was 78, which is classified as good. The average score for formulating hypotheses was 75, which is also classified as good. The indicator for planning experiments, interpreted as good, received a score of 77. In using tools and materials, students performed very well with a score of 83. Furthermore, after obtaining the practical results, students interpreted and applied the concepts, receiving a score of 90, interpreted as very good. The practical results obtained were then presented to measure the communication indicator, receiving a score of 87, interpreted as very good. The analysis of students' scientific process skills in the psychomotor aspect showed an average score of 83, with a very good interpretation.

Based on the presentation of scores for cognitive and psychomotor aspects, scores for each indicator of students' science process skills were obtained. At the problem analysis stage, both aspects get a very good interpretation. This can be seen in the learning process, where students are able to observe the problems given well and analyze relevant solutions to these problems. In a study conducted by Hidayati (2015), it was mentioned that the use of worksheets based on science process skills increased students' reasoning power. Students are invited to think about finding problems around them and trying to find out about the phenomenon themselves. From the observation, it was found that students discussed and collaborated in finding answers at the problem analysis stage. Discussion is a method that provides opportunities for groups of students to discuss concepts with the aim of gathering opinions, drawing conclusions, or compiling various alternative solutions to problems. (Minarni, 2016).

In the indicator of asking questions for the cognitive aspect, it got a score of 80 with a very good interpretation and in the psychomotor aspect of 78 it got a good interpretation. Students are encouraged to formulate problems that are relevant to the teaching materials that have been provided. During the implementation of learning, students ask things that are less relevant to learning, so that the problem formulation made is not in accordance with the problems given. According to Amelia (2022) in her research stated that the application of worksheets based on science process skills can improve critical thinking skills from the problem statement stage (aspects of asking questions) obtained through information in the previous stage.

Then, students formulate problems after reading related information. Similarly, on the hypothesis formulation indicator, students did not write complete and relevant hypotheses; they were still confused and not accustomed to writing hypotheses from a problem statement. This indicator received the lowest score in the overall science process skills, namely 77 for the cognitive aspect and 75 for the psychomotor aspect. Hypotheses are crucial for the scientific process, particularly for guiding research and experiments. Hypotheses enable the testing of reliable predictions and help scientists focus their attention on specific questions. Additionally, a good hypothesis must be based on existing knowledge and can be validated through experiments or observations (Brüssow, 2022). An example of a hypothesis is that the number of deaths among the animals tested will be affected if the concentration of areca nut extract is increased. Therefore, hypotheses are more than just initial ideas; they are important tools that help scientific research discover and understand new things.

In designing experiments, students wrote down the tools, materials, and procedures used. Some students were not familiar with the names of the laboratory equipment used, so the researcher provided knowledge about these tools and guided students to find information through the internet or other sources. In terms of cognitive and psychomotor aspects, this indicator obtained a score of 77 which is interpreted as good. In Wazni (2022)research stated that worksheets based on science process skills are one of the learning strategies that can train students to explore and develop scientific attitudes, one of which is designing experiments. When students have the ability to design their own learning process, chemistry learning becomes more meaningful. They should be able to design learning projects tailored to their needs, actively monitor their progress, and evaluate their learning outcomes. Thus, students are not only passive recipients of information, but actively participate in directing and controlling the learning process. (Fatnah et al., 2021).

The next indicator is the use of tools and materials. Students are assigned to make natural larvicides from areca nut extract according to the draft experimental procedure that has been made previously. At this stage students are also assigned to write down the treatment and observations obtained when conducting larvicide experiments from areca nut extract. The average score at this stage was 84 for cognitive aspects and 83 for psychomotor aspects, with a very good interpretation. This can be seen from the students' answers when writing down the treatments and observations, as well as the results of the larvicides they made. According to previous research by Megawati (2018), it was found that student worksheets based on science process skills can improve various aspects of science process skills, including the ability to use tools and materials. By engaging students in these activities, the worksheets help improve their ability to use tools effectively in a scientific context. The research conducted by the students can help improve their scientific process skills (Putra & Pebriana, 2022).

Students were assigned to connect the results of experiments on the production of larvicides from areca nut extracts with related knowledge to measure indicators of understanding and application of concepts. Students wrote discussions of the experimental results and summarized them. The results of data analysis for this indicator obtained a score of 86 for the cognitive aspect and 90 for the psychomotor aspect. These scores indicate that students not only

understand the scientific concepts taught but are also able to apply them effectively in product development. Science process skill-based worksheets involve observation, experimentation, and data analysis, which can encourage students to think creatively, enabling them to develop their ability to interpret and apply concepts (Purnama et al., 2024). The ability to apply these concepts is important because it demonstrates students' readiness to tackle more complex problems in future scientific research, as well as their capacity for innovation and finding science-based solutions. (Kurniawati, 2021).

In the communication indicator, students compiled a final report on the experiments they had conducted through presentations. Based on the assessment results of each group's presentation, the students' ability to convey the material was rated as very good, with a score of 83 in the cognitive aspect, while the psychomotor aspect received a score of 87. The students' ability to convey scientific results is an important part of developing scientific process skills. This communication process includes the presentation of data, findings, analysis, and comprehensive interpretation of project results. Student worksheets facilitate the teaching and learning process, enabling effective interaction between students and educators, which can enhance student activity, including improving students' scientific communication skills (Fadly & Andaria, 2021). By improving scientific communication skills, students can better convey research findings. This will help them enhance their critical thinking skills and deepen their understanding of scientific concepts (Qodarsih et al., 2023). In addition, the ability to communicate scientific results encourages students to be more thorough in collecting and analyzing data. It also improves their ability to argue scientifically based on evidence.

A product has characteristics that include aspects that can be perceived by the five senses, such as color, taste, texture, and aroma (Puspitasari et al., 2020). The results of the organoleptic test show that the natural larvicide of areca nut extract has a dark brown color, with a very thick texture, a bitter taste, and a distinctive aroma of areca nut. In the practicum, students were divided into six groups, each of which tested larvicides at different concentrations. Each group was given the same test animal, namely mosquito larvae with the same number of 20 heads per group. Areca nut extract was dissolved in distilled water with the same volume of one liter.

In group one with a concentration of areca nut extract of 5 mL, the percentage of larval mortality was 60%. Group two with a concentration of 6 mL of areca nut extract, obtained a percentage of larval mortality of 75%, group three with a concentration of 7 mL obtained a percentage of mosquito larvae mortality of 85%. Furthermore, group four with a concentration of 8 mL, observed a percentage of larval mortality of 90%, while groups five and six with a concentration of areca nut extract of 9 mL and 10 mL had the same percentage of larval mortality of 100%. According to WHO, the percentage of larval mortality of 95% of larvae is said to be effective (Noya et al., 2022). Based on the practical results obtained, the effectiveness of natural larvicides from areca nut extract is at a concentration between 9 mL, where the percentage of mosquito larvae death is 100%. Temephos also stops the action of a group of enzymes called cholinesterase (Adhikari & Khanikor, 2021). This type is present throughout the body, such as the nervous system, brain, and bloodstream. In addition, nausea, headache, loss of muscle coordination, and difficulty breathing are symptoms of acute exposure (Ali, 2020). Therefore, it is necessary to make an effort to obtain natural insecticides, one of which is by using areca nut extract (*Areca catechu* L.) which is able to kill mosquito larvae to replace Temephos.

CONCLUSION

The application of science process skills-based worksheets in the project of making natural larvicide from areca nut extract can help students develop these science process skills. The

implementation, which includes theoretical and practical learning activities, can develop skills covering cognitive and psychomotor aspects. Student learning outcomes in the learning process using science process skills-based worksheets on cognitive aspects amounted to 82 which was interpreted as very good, while on psychomotor aspects a score of 83 was obtained which was also interpreted as very good. In the larvicide making project, effective results were obtained at a concentration of 9 mL with a percentage of mosquito larvae death of 100%. The results of this study can be used as a reference for the development of environment-based worksheets. The products produced in this project can be used as effective and environmentally friendly innovations in mosquito population control.

RECOMMENDATIONS

Researchers suggest applying science process skill-based worksheets to material that is not commonly studied by students in order to encourage curiosity and critical thinking.

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