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Research Artikel

IMPLEMENTATION OF A PROJECT-BASED WORKSHEET USING ALOE VERA GEL AS A NATURAL STABILIZER IN PURPLE SWEET POTATO ICE CREAM TO INCREASE NUTRITIONAL LITERACY

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Abstract

The problem of low science literacy needs to be used as a reference by the government in improving the learning system in Indonesia. This research aims to produce teaching materials in the form of STEM-Based Electronic Student Worksheets (E-LKPD) to Improve Science Literacy Skills in Environmental Change Materials. The method used is Research and Development (R&D) with a 4-D development model (Define, Design, Develop, and Disseminate). The development process goes through a validity test of 2 experts, a readability test of 15 students, and a field trial by 1 biology teacher and 35 students. Pretests and posttests were conducted using multiple-choice test instruments consisting of the same 10 questions. The results of the research showed that the developed E-LKPD had an average validity percentage of 85.2% with very feasible criteria. In the readability test, the average percentage of E-LKPD reached 86.2% with very feasible criteria. While in the field trial, the responses of teachers and students showed very feasible criteria with percentages of 81.25% and 82.25%. There was an increase in the average scientific literacy skills measured through the test instrument. The average result of scientific literacy skills before the implementation of E-LKPD was 57.3 while after the implementation of E-LKPD it increased to 79.6 with an N-Gain of 0.50 in the moderate category. Based on these results, it can be concluded that E-LKPD is very feasible to use in learning activities and there is an increase in scientific literacy skills after the use of E-LKPD in the learning process.

Keywords: *Electronic Student Worksheets; Environmental Change Material; Learning Approach; STEM; Science Literacy Skills.*

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INTRODUCTION

The skills of 21st-century students include literacy, competence, and character (Pursitasari et al., 2023). Critical thinking, analysis, cooperation, and collaboration are important components in problem solving (Ate & Lede, 2022). These skills are related to science literacy (Hikmawati et al., 2021). Nutrition literacy is part of science literacy and plays a significant role in chemistry education (Rochman et al., 2018).

Nutrition literacy is the ability of an individual to obtain, process, and understand basic nutritional information in order to make appropriate nutritional decisions. This literacy encompasses knowledge, skills, and attitudes in selecting, managing, preparing, and consuming food based on information from various sources (Silva, 2023). It is essential to educate students about the importance of nutrition in order to prevent chronic diseases in the future, given the abundance of unhealthy foods available (Yan et al., 2023).

Efforts to improve students' nutritional literacy require contextual and meaningful learning strategies through learning resources, media, and a competent education system. The selection of learning models is analyzed based on student conditions, learning materials, and facilities (Hasibuan et al., 2024). Project-based learning teaches students to solve problems through planning, designing, completing projects, presenting, and evaluating (Pratiwi & Setyaningtyas, 2020). Project-based worksheets can guide students in directing practical steps and encourage increased motivation and creativity (Aprianto, 2023). Practical activities carried out through projects can provide concrete and meaningful learning experiences in developing students' cognitive and affective abilities (Hernawati et al., 2021).

One chemistry topic that can be studied through project-based learning is colloids, as they are abstract concepts that can be understood through concrete examples in everyday life (Devi et al., 2022). The project that can be carried out is making ice cream with the addition of purple sweet potato as the main raw material which gives it a distinctive color and unique taste (Siswati et al., 2019). A solid source of non-fat from sweet potatoes is beneficial for health because the anthocyanin content functions as an antioxidant in absorbing toxins, oxidants, and inhibiting blood cell clumping (Fahrullah et al., 2022). Purple sweet potato enhances the appeal of ice cream through color, taste, aroma, and helps understand the concept of colloids in everyday life (Tari et al., 2021).

According to the Indonesian National Standard (SNI), ice cream is a mixture of milk, animal fat, sugar and other permitted additives and is processed by freezing (Nuryadi et al., 2020). One natural additive that can function as a stabilizer is aloe vera gel, because it contains water-soluble glucomannan that can stabilize emulsions. Aloe vera gel belongs to the hydrocolloid group, which consists of water, minerals, enzymes, organic acids, and carbohydrate compounds such as monosaccharides and polysaccharides, including cellulose, hemicellulose, and pectin. Pectin plays a crucial role as a gel-forming agent and thickener in the food industry, thereby providing numerous benefits (Muni et al., 2019).

Previous research conducted by Nasrudin et al. (2023), discusses increasing the nutritional literacy of elementary school children through science learning which focuses on the topics of the digestive organ system and the circulatory organ system. Study Fahrullah et al. (2022) using purple sweet potatoes as raw material for ice cream in training and mentoring in using purple sweet potatoes. In addition, research was carried out by Yanuarda et al. (2014) namely analyzing the effect of using aloe vera gel as an ice cream stabilizer which focuses on the right concentration in producing high quality ice cream. Based on previous research, there has been no study that integrates the development of project-based worksheets focused on making purple sweet potato ice cream with the addition of aloe vera gel as a natural stabilizer directly in the context of chemistry learning to improve students' nutritional literacy.

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Literacy aspects can generally be measured using a single worksheet. However, not all literacy aspects can be developed in a single learning stage, as each aspect has different measurement indicators. For example, the instrument used to measure knowledge will differ from the instrument used to assess attitudes or skills. This aligns with research (Zhang et al., 2023), which explains that the instruments used to measure knowledge differ from those used to measure competencies.

METHOD

The research method used was a mixed method combining qualitative and quantitative approaches. The quantitative approach was used to analyze the pretest and posttest data using specific statistical calculations, while the qualitative approach was used to describe students' responses to the use of project-based worksheets (Creswell & Clark, 2017). This research uses a pre-experimental design approach with a one group pretest-posttest design method in one class (Sugiyono, 2021). This design was chosen due to limitations in forming comparison groups and considering the homogeneous conditions of the class. However, this design makes it possible to determine the effect of learning by comparing the pretest and posttest results in the same group.

This research consists of several stages, namely: 1) The preparation stage begins with analyzing KI, KD, syllabus, relevant journals, preliminary studies, creating instruments, and validating instruments; 2) The implementation stage is the application of project-based worksheets; 3) The final stage focuses on data processing. The research instruments used were validated by two expert lecturers from the Chemistry Education Study Program and one teacher from Muhammadiyah 4 High School in Bandung. The validators provided several suggestions for improvement regarding the wording of the questions to make them clearer and less ambiguous, so revisions were made before the instruments were used in the study. Thus, the instruments used can be trusted to accurately measure student competency achievement.

The research implementation time was carried out in March 2024, starting with a preliminary test and implementing project-based worksheets in May 2024 to class XI IPA 3 students at SMA Muhammadiyah 4 Bandung City.

RESULTS AND DISCUSSION

In this section, the results of the research and analysis that have been carried out in implementing a project-based worksheet on the use of aloe vera gel as a natural stabilizer in purple sweet potato ice cream to increase nutritional literacy are presented as follows.

Description of Student Learning Activities

The project-based worksheet display consists of several stages, namely 1) analyzing the problem, 2) designing the project. 3) conducting research, 4) compiling a product draft/prototype. 5) measure, assess, and improve the product, and 6) finalize and publish the product (Rahmat et al., 2023). Each stage is designed to encourage students to actively engage in the process of solving real-world problems, which forms the basis for developing students' scientific creativity.

Project-based learning is used because it can create a meaningful learning atmosphere because it is centered on process, time, and focuses on problems (Novitasary, 2023). The overall value of the implementation of student activities in project-based learning is presented in Table 1.

Based on Table 1, the average implementation of student learning activities was 88%, indicating that the learning activities went very well. The highest average score was in the problem analysis stage with a score of 91.75%. This occurred because the students had a high level of curiosity about the material, enabling them to understand the real problems from the discourse provided (Hernawati et al., 2021). This finding is consistent with research (Ramadhan & Hindun, 2023), which states that project-based learning can help students understand concepts more deeply, create meaningful learning experiences, and train problem-solving skills. Projects are also carried out through group work and discussions, which provide opportunities for students to actively

express their ideas and understand the views of their peers (Sumarni et al., 2019). In addition, according to Samsiyati (2023), the high level of learning implementation is also influenced by the high motivation of students in participating in the learning process.

Table 1. Recapitulation of Implementation of Student Learning Activities

Group	Student Learning activities at each stage (%)						Average	Interpre-tation
	1	2	3	4	5	6		
1	87.5	90	87.5	83.33	87.5	87.5	87.22	Very good
2	92	92.5	93.75	91.7	100	87.5	92.9	Very good
3	95.5	90	87.5	79	75	93	86.67	Very good
4	92	92.5	87.5	83.34	75	87.5	86.3	Very good
Average	91.75	91.25	89	84.34	84.37	87.87	88	Very good
Interpretation	Very good	Very good	Very good	Very good	Very good	Very good		

Information:
Level 1 : Analyze the problem
Stage 2 : Designing the project
Stage 3 : Conduct research
Level 4 : Sorting *draft/prototype* product
Level 4 : Sorting *draft/prototype* product
Stage 5 : Measuring, assessing, and improving the product
Stage 6 : Finalization and product publication

The lowest average score was in the product draft/prototype development stage, at 83.34%. This low score was due to students using inappropriate references when completing their worksheets, as well as a lack of guidance from teachers in directing their search for references from journals. This is because students are more accustomed to using books or the internet, so it is important for teachers to introduce them to ways of searching for information from scientific journals (Isrokatun et al., 2021). In addition, the information obtained during the product draft/prototype development stage must be accountable. Therefore, the references used must refer to reliable sources (Jeka et al., 2023).

Analysis of Students' Nutrition Literacy Abilities

The results of implementing student activities at each stage of project-based learning are related to increasing students' nutritional literacy. The use of project-based worksheets on colloid ice cream making material aims to increase students' nutritional literacy. The students' nutritional literacy skills were obtained from the pretest questions and posttest questions. The pretest questions are done by students before applying the LK, while the posttest questions are done after applying for the LK.

The student nutritional literacy ability test consists of 10 essay questions. This test refers to the nutritional literacy indicator which has four indicators, namely: 1) content about types of food and the importance of nutrition, 2) context about nutritional sources, 3) skills in managing a balanced diet, 4) positive attitude in accepting invitations/ recommendations for consuming healthy and nutritious food and implementing healthy living behavior in daily life (Nasrudin et al., 2023). Average value *N-Gain* for each indicator can be seen in Table 2.

Based on Table 2, the average N-Gain value for each indicator is 0.50, which falls into the moderate category. This finding indicates that the use of project-based worksheets through the production of purple sweet potato ice cream with aloe vera gel as a natural stabilizer contributes positively to improving students' nutritional literacy. However, this improvement has not yet reached a high category, possibly due to the research design used, which is a single-group experiment without a control group. This aligns with the findings of (Wee et al., 2015), which showed an increase in students' understanding within the moderate category. This improvement was achieved through a single-group experimental design without a control group, thereby limiting the ability to directly attribute the improvement to the intervention provided.

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Table 2. Average Value *N-Gain* on Each Indicator

Nutritional Literacy Indicators	*N-Gain*			Average	Interpre-tation
	High	Currently	low		
Content about types of food and the importance of nutrition	0.67	0.49	0.48	0.55	**Currently**
Context about nutrient sources	0.34	0.21	0.56	0.37	**Currently**
Skills in managing a balanced diet	1	0.63	0.75	0.80	**High**
A positive attitude towards accepting invitations/advice to consume healthy and nutritious food and implementing healthy living behavior in daily life.	0.28	0.27	0.36	0.31	**Currently**
Average				0.50	**medium**

The highest average N-Gain value was obtained in the third indicator, namely skills in managing a balanced diet, with a value of 0.80. This achievement shows that the project-based learning activities that were designed successfully developed students' applied skills in a real context, particularly in the aspect of planning healthy food consumption.

The results obtained are in accordance with the search Sugiarto et al. (2023), that knowledge of balanced nutrition can influence a person's attitudes and behavior. Therefore, choosing the right food comes from the person's knowledge (Aulia, 2021). A person's high level of knowledge in managing a balanced diet can influence their ability to apply nutritional information in their life (Rarastiti, 2022).

Meanwhile, on average *N-Gain* The lowest is found in the fourth indicator, namely a positive attitude in accepting invitations/recommendations to consume healthy and nutritious food and implementing healthy living behavior in daily life with a value of 0.30. This low achievement indicates that although the learning approach used can improve students' knowledge and skills, changing attitudes still requires more in-depth and sustained intervention.

The low N-Gain value on the behavior indicator occurs due to students' lack of cognitive in nutritional literacy. According to Chandrasekara & Jayasinghe (2022), a person's attitude depends on learning by considering the nutritional knowledge obtained. However, someone's good knowledge of nutrition does not guarantee that that person will also have a good attitude. Based on Mashur et al. (2023), human attitudes can be influenced by personal experience, the influence of other people, culture, mass media, emotional factors, and educational institutions. Therefore, it is necessary to get used to accepting invitations to consume healthy and nutritious food in order to increase students' awareness of consuming nutritious food (Jatmikowati et al., 2023).

Average value results *N-Gain* Each indicator of nutritional literacy shows that maximum test results are not always obtained by the high achievement group. Likewise, the low achievement group does not always get minimum test results. This shows that the research conducted can help students in each achievement group to improve their nutritional literacy skills. Average value *N-Gain* Based on Table 2, the nutritional literacy indicator is 0.50, which is included in the moderate interpretation. This shows that there has been a significant increase in students' nutritional literacy skills.

The results of nutritional literacy research which are still in the moderate category are relevant to the results of the analysis (Hanun, 2022), which states that the level of students' nutritional literacy is in the medium category. This is caused by the use of new models, methods and teaching materials which require adaptation to produce good learning. Meanwhile, according to Amalia & Alfiansyah, (2022), the factors causing less than optimal learning outcomes are caused by the condition of the students, the way teachers implement learning

models in the classroom, the choice of learning models, and the teacher's lack of ability. Based on this, to increase students' nutritional literacy, it is necessary to develop and adapt learning so that it will have a positive effect on aspects of students' nutritional literacy.

Analysis of the Characteristics of Purple Sweet Potato Ice Cream

The students' activity began by making purple sweet potato ice cream using two different stabilizers, namely aloe vera gel and CMC. The purple sweet potato ice cream that had been made underwent several tests to determine the characteristics and quality of the ice cream. The stabilizer formulations used are 0%, 0.1%, 0.2%, 0.3% and 0.4%. After making the ice cream, several tests were carried out to determine the effect of the aloe vera gel stabilizer formulation and CMC. The test consists of a melting speed test and organoleptic tests including color, aroma, texture and taste carried out by students. Meanwhile, the total solids test is carried out by the teacher. Apart from that, the teacher made and tested purple sweet potato ice cream with a 0% formulation with the same ingredient composition as each group of students. As for the stabilizer concentration of 0.3%, for both aloe vera gel stabilizer and CMC, there was a technical error from group 3 because the sweet potato used was yellow sweet potato. This affects the test results because yellow sweet potatoes and purple sweet potatoes have different contents.

a. Melting Speed Test

The melting speed test is carried out by leaving frozen ice cream at room temperature until it melts completely and then calculating the melting time. The melting speed test results of purple sweet potato ice cream can be seen in Table 3.

Table 3. Melting Speed Test Results for Purple Sweet Potato Ice Cream

Result	0 %	Stabilizer							
		Aloe Vera Gel				CMC			
		0.1%	0.2%	0.3%	0.4%	0.1%	0.2%	0.3%	0.4%
Melting speed /10 grams (second)	910	925	944	960	952	965	1037	1054	1178

The melting speed test results obtained based on Table 3 are in accordance with SNI, namely between 15-20 minutes (Maylina & Sari, 2023). In the 0% stabilizer formulation, melting was obtained for 910 seconds. The addition of stabilizers to both aloe vera gel and CMC showed an increase in melting time as the amount of stabilizers used increased. This is caused by the effect of stabilizers on the texture and viscosity of the ice cream mixture. Analysis results Zainuri et al. (2020) shows that the more stabilizer concentration added, the longer the melting speed will be.

Apart from that, the use of solid ingredients also contributes to accelerating the melting process of ice cream. The 0.3% aloe vera gel stabilizer formulation has decreased to the 0.4% aloe vera gel stabilizer formulation. This happens because the 0.3% formulation uses a different sweet potato, namely yellow sweet potato, which allows the melt to be different from purple sweet potato. According to Faizah et al. (2023), the melting speed of ice cream is usually influenced by several factors such as stabilizers, emulsifiers, processing processes, and storage processes. Besides that, Kumalasari & Ulilalbab (2021) emphasizes that quality ice cream has a smooth texture and high viscosity so that it does not melt easily.

b. Organoleptic Test

Organoleptic tests are carried out by assessing color, aroma, texture, and taste. The tests carried out by students are in accordance with the preliminary tests carried out by the teacher. On average, the ice cream produced is purple in color, sweet potato flavored, has a smooth texture, and tastes of purple sweet potato. However, there were formulations that did not comply with the preliminary test, namely in the treatment with the

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addition of 0.3% aloe vera gel stabilizer and CMC. This happened because there was a technical error in group 3 which used yellow sweet potatoes. So the results obtained are not in accordance with the preliminary tests carried out. The results obtained in this test are influenced by the ice cream making process such as stirring, heating and mixing. The organoleptic test results can be seen in Table 4.

Table 4. Organoleptic Test Results of Purple Sweet Potato Ice Cream

Organoleptic	0%	Stabilizer							
		Aloe Vera Gel				CMC			
		0.1%	0.2%	0.3%	0.4%	0.1%	0.2%	0.3%	0.4%
Colour	3	3	3	1	3	2	2	1	2
Aroma	3	2	2	1	2	2	2	1	2
Texture	3	2	3	3	3	2	2	3	3
Flavor	3	3	3	1	2	2	2	1	2

Information:
Color : 1) Not purple 2) Purple 3) Very purple
Aroma: 1) Does not smell of sweet potatoes 2) Smells of sweet potatoes 3) Strongly smells of sweet potatoes
Texture : 1) Not smooth 2) Smooth 3) Very smooth
Taste : 1) No taste of yam 2) Taste of yam 3) Very taste of yam.

The organoleptic results on color, aroma, texture and taste of each stabilizer formulation based on Table 4 are in accordance with SNI and preliminary test results. The color, aroma, texture and taste of ice cream are within normal limits. The color, aroma and taste produced are in accordance with the ingredients used. The resulting texture is obtained from the ice cream making process. However, in the formulation of 0.3% aloe vera gel stabilizer and CMC, inconsistent results were obtained. This happens because this formulation uses yellow sweet potatoes which can affect the organoleptic results.

The difference in color results in each formulation is caused by the ice cream making process, the amount of ingredients used, and the addition of milk. The purple color is produced from using purple sweet potatoes as a natural dye because they contain anthocyanin which is a natural pigment that provides color (Sari et al., 2022). Analysis results of Oktafiyani & Susilo (2019), showed that the addition of milk can reduce the original color of purple sweet potato so that the color fades. Apart from that, the color is also influenced by the mixing process evenly so that the color becomes more homogeneous (Sudaryani et al., 2020).

The analysis results obtained showed that the aroma of purple sweet potato ice cream was reduced. This is in accordance with the statement Faizah et al. (2023), that the aroma of milk can produce a distinctive odor which can change if it comes into contact with other compounds or objects. Based on SNI quoted by Faizah et al. (2023), the aroma of good ice cream is a normal aroma and corresponds to the ingredients used in the manufacturing process. The resulting texture differences are caused by the stirring and pasteurization processes. Stirring aims to mix all the raw ice cream ingredients and prevent the formation of large and hard ice crystals. Effective mixing contributes to the soft and smooth texture of the ice cream (Alfadila et al., 2020). The pasteurization process also affects the texture of ice cream because it can help dissolve and mix the ingredients, resulting in a good texture (Sudaryani et al., 2020). Quality ice cream has a smooth texture and delicious taste. The smooth texture of ice cream is influenced by raw materials, especially fat, which provides softness and prevents the formation of crystals (Faizah dkk., 2023).

The analysis results obtained concluded that the use of aloe vera gel stabilizer did not affect the taste of purple sweet potatoes. This is proven by the 0% stabilizer formulation which produces a very strong taste of purple sweet potato. According to (Faridah et al., 2023), the taste of ice cream is influenced by basic ingredients such as sugar and milk. Analysis results Hadju et al. (2024),

emphasized that the taste of ice cream is also influenced by chemical compounds, temperature, ingredient composition, and interactions between components. Apart from that, the addition of ingredients to ice cream must follow standards to produce good quality (Wiarta, 2022). This study used purple sweet potato as a basic ingredient, so the ice cream flavor is the result of a mixture of basic ingredients and additional ingredients. The taste of good ice cream is a normal taste and corresponds to the ingredients used in the manufacturing process.

c. Total Solids Test

Total solids testing is carried out using the gravimetric or weighing method. This test aims to determine the total amount of solids such as carbohydrate, fat and protein content in ice cream. However, in this study, carbohydrate, fat and protein content were not tested. Based on SNI, a good total solids is at least 34%. Meanwhile, according to Rahmatullah & Daniyanti (2019), good total solids range between 35%-42%. The total solids test results can be seen in Table 5.

Table 5. Total Solids Test Results for Purple Sweet Potato Ice Cream

Result	0%	Stabilizer							
		Aloe Vera Gel				CMC			
		0.1%	0.2%	0.3%	0.4%	0.1%	0.2%	0.3%	0.4%
Water content (WC)	66	65.59	64.74	61.11	61.57	60.66	60.62	58.59	58.58
Total Solids (TP)	34	34.41	35.26	38.89	38.43	39.34	39.38	41.41	42

The total solids test results obtained based on Table 5 are in accordance with SNI, namely the total solids of ice cream is at least 34%. The 0% stabilizer formulation obtains a total solids of 34%. The addition of aloe vera gel and CMC stabilizers resulted in increasing total solids along with the amount of stabilizer used. The addition of 0.3% aloe vera gel stabilizer decreased to the 0.4% aloe vera gel stabilizer formulation. This can happen because the 0.3% aloe vera gel formulation uses yellow sweet potato which has different contents from purple sweet potato so it can affect the total solids.

Total solids affect the texture of ice cream because it includes all the solid ingredients used. If the total solids are too low, the ice cream texture can become rough. Conversely, if the total solids are too high, the texture can become soft and sticky. Total solids include all the solid components in ice cream, such as carbohydrates, fat, and protein (Mahrita dkk., 2022). Based on SNI, carbohydrate levels in ice cream do not have a standard limit. Meanwhile, the requirements for fat and protein content in ice cream are 5% and 2.7% respectively (Zainuri dkk., 2020).

The analysis results show that purple sweet potato and stabilizer concentration 74 affect the total solids of ice cream. This is caused by the carbohydrate, fat and protein content in purple sweet potatoes which can increase the total solids of ice cream. The carbohydrates in this study came from purple sweet potatoes and sugar. Apart from carbohydrates, purple sweet potatoes are also rich in vitamins and minerals that are beneficial for the body (Reymon dkk., 2019). The protein content is obtained from egg yolk and skim milk, while the fat comes from added milk fat.

Based on the results of tests that have been carried out, aloe vera gel can be used as an alternative stabilizer in making ice cream. This is because the characteristics of the ice cream produced are not much different from commercial stabilizers such as CMC. Testing of melting speed, organoleptic and total solids on the aloe vera gel stabilizer showed results that were equivalent to the CMC stabilizer. This finding is in line with the analysis Yanuarda et al. (2014), which states that the use of aloe vera gel has a positive effect on the quality of ice cream in terms of viscosity, overrun, melting speed and total solids. Similar research by Wiarta (2022), shows that using aloe vera juice in ice cream produces a delicious taste, attractive color, soft texture and distinctive aroma. Apart from that, processing aloe vera into an ice cream stabilizer does not damage the antioxidant content and has a longer shelf life of around 5 days.

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CONCLUSION

Data analysis revealed that student activities in project-based learning achieved an 88% rating in the very good category. Additionally, there was increase in students' nutritional literacy skills regarding colloidal materials, as indicated by an average N-Gain value of 0.50 in each nutritional literacy indicator and achievement group. This value is considered moderate. These results suggest that using project-based worksheets that utilize aloe vera gel as a natural stabilizer in purple sweet potato ice cream effectively improves students' nutritional literacy. The ice cream's physical characteristics, including its melting speed, organoleptic properties, and total solids content, met the quality standards set forth in SNI No. 01-3713-1995. Thus, the results of this study can contribute to the development of practicum learning activities in education where research steps are organized into an experimental procedure outlined in worksheet form. These worksheets can serve as tools for teachers to guide students in conducting simple experiments, analyzing data, and drawing scientific conclusions with contextual material that supports a project-based learning approach.

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