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Development of a Manual Book on Processing Flour of Mole Crab to Provide Students Science Process Skills

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Abstract: A lack of understanding of how to integrate Science Process Skills (SPS) into learning and evaluation can hinder vocational high school students' development of more complex skills. These students are required to have more skills than students in general schools. This study aims to develop a manual book on making nutrient-rich flour to teach SPS to vocational high school students majoring in culinary arts and industry. The study uses an experimental model with a group pretest-posttest design. Experts validated the manual book to determine the feasibility of its content, language, and design, giving it an Aiken-V score of 0.86 (valid). The manual book was implemented in the classroom with culinary arts and industry students at SMKN 7 Bengkulu. Students' SPS (observation, interpretation, hypothesizing, designing an experiment, implementing concepts, and using tools and materials) were measured based on pre- and post-test results. Students majoring in industry had an N-Gain score of 0.41 (moderate), and students majoring in culinary arts had an N-Gain score of 0.70 (moderate). Using a manual book is suitable for teaching students because it stimulates and improves their SPS. The manual can serve as a model for developing SPS because it contains basic concepts, worksheets to enhance SPS, and evaluation formats to measure SPS.

Keywords: Science Process Skills, Manual Book, Learning

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1. Introduction

Learning science is a complex combination of research results and daily life activities. Encouraging students to apply scientific attitudes and methods often presents obstacles in the science learning process (Sari *et al*., 2024). The scientific method is the way to gain knowledge. It involves studying, observing, and carrying out scientific experiments (Wandini *et al*., 2022).

Innovation is a key part of the food processing context, which also demands a certain set of SPS related to activity and thinking (Agustin *et al*., 2016). These skills need to be provided to support life skills which are very useful for meeting the needs of the wider community, because these abilities can give rise to creativity and provide skills strengthening (Sumarni, 2023). These skills can be taught in educational settings, such as vocational schools, particularly those specializing in culinary arts. These groups of students can become active drivers of innovation, including in the context of food processing. According to Hasnunidah, (2017) Creativity in learning has long been a focus of educational research. The results of the research gap analysis show many relationships, including those concerning students, activities, and the scientific process.

Science process skills have many applications in education and other fields. One way to strengthen this skill is to incorporate innovative content into teaching materials. According to Cikarge & Utami, (2018) one type of teaching material that can contain innovative content is a manual book. This type of manual book contains information about processing and production stages, as well as the product's various uses. The manual that will be developed will also contain content that provides the necessary skills for processing food, which are in high demand among vocational students.

Based on observations conducted by researchers at SMKN 7 Bengkulu (vocational school, majoring culinary art), it was found that, during learning activities involving printed books, the research problems were strengthened. The context of practical activities tends to follow the standard recipe, using the same ingredients and measurements for food processing. To develop qualified science process skills, it is necessary to provide an innovative food processing-integrating SPS through a procedural manual book.

This procedural manual book is more than just a source of innovative content; it also serves as a tool for learning, equipping SPS, pushing for a shift in mindset and fostering the development of sustainable perspectives (Alam, 2022). This competency is developed through education in sustainable development. Implementing sustainable development education in learning integrates values and perspectives on sustainable development, including socio-cultural, environmental, and economic aspects (Rahmawati *et al*., 2021). One pedagogical approach that has been strengthened is the validation of learning devices as tools that measure and evaluate the development of student and educator competencies (Cebrian et al., 2020).

Teachers frequently lack a comprehensive understanding of integrated SPS in learning when implementing SPS (Hafizan et al., 2012). Furthermore, the assessment of learning often places more importance on conceptual knowledge than on integrated SPS. This problem can hinder the growth of more complex skills necessary for vocational education (Koomson et al., 2024; Rifai, 2014). To integrate SPS into vocational education, a well-designed, consistent curriculum that aligns with industry needs is required (Hrmo et al., 2016; Yu et al., 2024).The purpose of this study is to provide vocational education students with SPS by developing a manual on food processing using crab mol. Data will be collected by measuring the abundance of crab mol on the coast of Bengkulu, a potential source of raw materials for alternative animal protein flour products. The nutritional content, shelf life, and product safety of the data obtained will be measured. Then, the data will be incorporated into instructional materials in the form of a procedural guidebook. This guidebook will provide step-by-step instructions for producing the products, thereby fostering a scientific mindset among students. According to the research gap analysis, instructional materials with innovative content can also promote character education among students. This study is expected to enhance students' SPS capabilities in developing the biological potential of sea horns as a food source in the Bengkulu region.

2. Method

Research Design and Sample

The study employed an experimental model with a pretest-posttest design (Nayeri et al., 2023). The research sample was selected using purposive sampling (Kayanja et al., 2025). Two classes of 11th-grade vocational high school students majoring in culinary arts and industry were selected. The research design is presented in Table 1.

Table 1 Research Design

Group	Pre-test	Treatment	Post-test
Industry	O_1	X	O_2
Culinary art	O_1	X	O_2

Explanation:
O1 = Pretest
O2 = Posttest
X = treatment using the manual book.

This study was conducted with two experimental classes, with no control group. The instruments used to measure science process skills were pre- and post-tests.

Research Instrument

The test instruments were developed based on SPS indicators (Hunegnaw & Melesse, 2023) in the context of processing animal flour from mole crab. The instrument parameters are presented in Table 2.

Table 1 Parameter Instrument

Indicator	Description	Nr Question
Observation	Students can correctly gather facts on one of the following keywords: nutrition, healthy, energy, hygienic, malnutrition, nutritional sources, and healthy generation.	1, 2

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Indicator	Description	Nr Question
Interpretation	Students can correctly connect their observations to one of the three keywords: processing, access, or production.	3, 8
Make a Hypothesis	Students can correctly make a hypothesis and explain an event using one of the following keywords: basic needs, food, expensive imports, protein, and processed food.	4, 9
Planning Experiments	Students can correctly identify food sources and plan processed innovative foods.	5
Applying Concepts	Students correctly apply the concept of food diversification to one of the keywords: nutritious, edible, and stable.	6, 7
Using Tools and Materials for Experiments	Students can use and understand the proper application of necessary tools and materials.	10

Manual Book Design

The framework of the manual book is based on food diversification, flour processing, nutrition, and applied science concepts. The design of the manual book includes an introductory section on food shortages, natural resource potential, and seaweed; a main section on food diversification and the utilization of mole crab as a nutrient-rich food source; a section on flour processing techniques using mole crab; and a concluding section on the project report and SPS evaluation. Manual book design presented in Figure 1.

Figure 1. Manual Book Design

Data Analysis

The feasibility of the content in the manual book was tested using a questionnaire-based validation test. Data from the manual book feasibility test was obtained using a 4-point scale questionnaire. Then, the total validation score was calculated as a percentage using the Aiken-V formula (Abraham et al., 2024). The SPS data analysis obtained from the pre-test and post-test in both the culinary arts and industry classes used n-gain (Wahab et al., 2018).

3. Result and Discussion

The manual was developed to provide vocational school students with SPS in the context of processing mole crabs flour as a nutrient-rich food source. Figure 1 shows the sections of the manual.

(a) (b)

Figure 2. Manual Book Design (a) Book Cover, (b) Potential for Mole Crab

Four experts validated the design of the manual book to determine the suitability of the guidebook's content, language, and design. Additionally, students tested the manual for readability. The results of the expert validation are presented in Table 3.

Table 3. Manual Book Validation Results

No	Aspect	Average Score	Description
1	Content	0,85	Valid
2	Language	0,92	Valid
3	Design	0,85	Valid

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Total Average	0,86	Valid

Table 3 shows that the information and activities in the manual related to processing mole crab flour as a nutrient-rich food also equip students with SPS skills, such as observation, hypothesis formulation, and experimental design. Similarly, the language and design of the manual meet the validity requirements. From a linguistic perspective, the language is clear and effective. Additionally, the manual is visually appealing in terms of color, layout, and graphic selection. Recent studies consistently support the effectiveness of using modules to produce learning materials in various subjects and educational contexts. Validity is generally assessed in terms of the content, construction, practicality, and effectiveness of the use of the learning modules (Leny et al., 2021).

In addition, another consideration in the development of this manual book is the learning design that is able to equip SPS students at every step. This is in line with the opinions of (Sriyanto & Masrukhin, 2019) and (Cirigliano et al., 2020), who state that institutions must consider the validity and effectiveness of these modules so that the developed modules contain high-quality content, active learning methods, competent instructors, the appropriate use of technology, and a supportive learning environment to improve learning outcomes.

After being validated by experts and revised based on their input, this manual was implemented to measure students' scientific process skills in culinary arts and industry majors. Figures 3 and 4 present the SPS data for students in the two classes for each indicator.

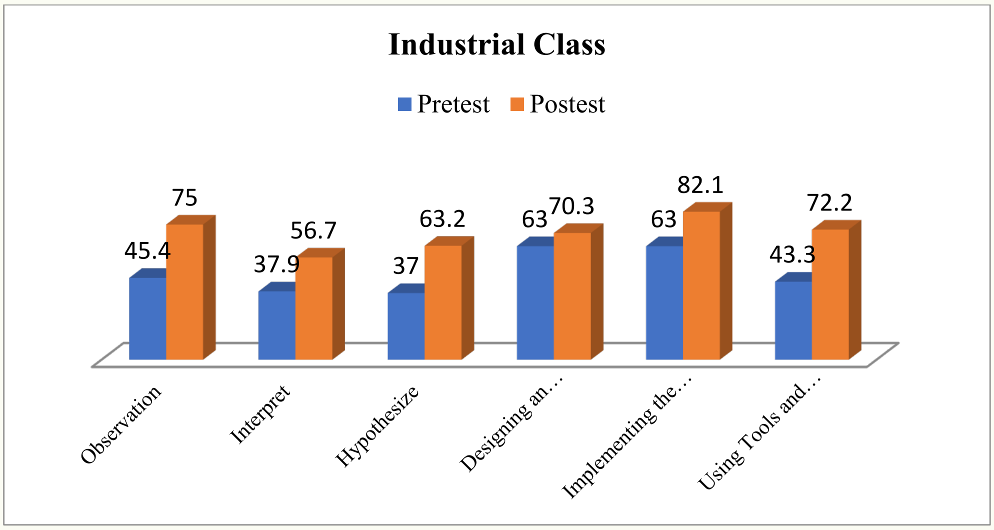

Figure 2. Industrial Class Pretest and Posttest Results

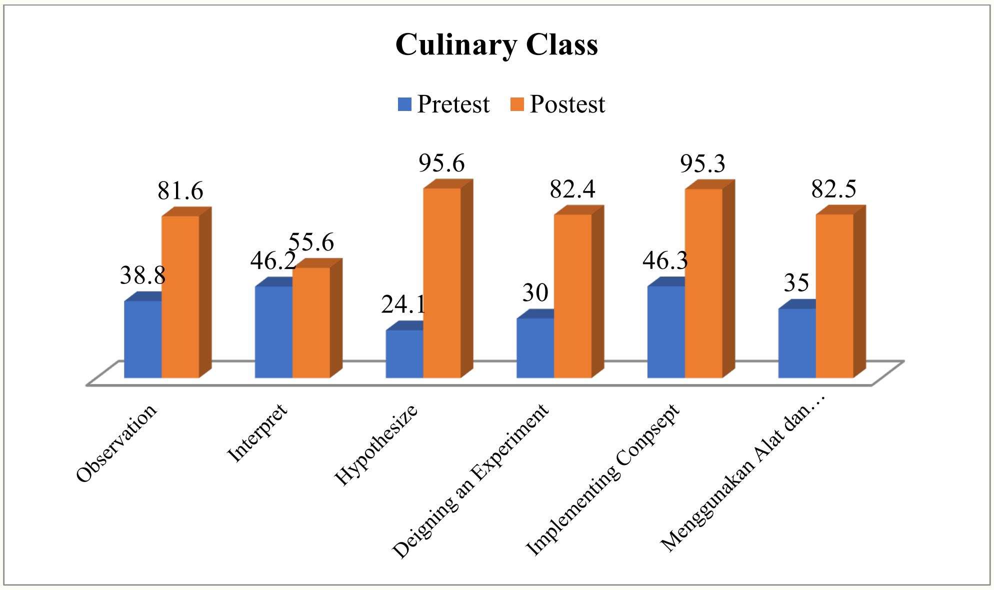

Figure 3. Culinary Class Pretest and Posttest Results

Figures 3 and 4 indicate that the industrial class performed worse on the post-test than the culinary class. Table 4 presents the N-Gain review of each SPS indicator in the culinary arts and industrial class.

Table 4. N-Gain of Each SPS Indicator in the Culinary Arts and Industrial Class.

No	Science Process Skills Indicators	Industrial Class		Culinary Class	
		N-Gain	Category	N-Gain	Category
1	Observing	0.54	Medium	0.70	High
2	Interpreting	0.30	Medium	0.17	Low
3	Hypothesizing	0.42	Medium	0.94	High
4	Designing Experiments	0.20	Low	0.75	High
5	Applying Concepts	0.52	Medium	0.91	High
6	Using Tools and Materials	0.51	Medium	0.73	High
	Average	**0,41**	**Medium**	**Medium**	**Medium**

Table 4 shows improvements in both the culinary arts and industry classes. Overall, the culinary arts class had higher n-gains than the industry class in almost every indicator. In the culinary arts class, interpreting indicator scores were the lowest, while in the industry class, designing experiments indicator scores were the lowest.

The written measurements on each SPS indicator show that industrial classes have difficulty describing the answers to each indicator. However, they demonstrate excellent practical skills and proficiency in using tools and materials. They focus more on cooking skills than on analyzing questions. This is evident in their ability to design an experiment substituting mole crab flour for flour in food processing.

The SPS indicator with the smallest n-gain among the six measured in industrial class students is designing experiments. This indicator is one of the key components of SPS and is based on observation and hypothesis skills (Schwichow et al., 2022). The data shows that the observation and hypothesis formulation scores in the industrial

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class fall into the medium category, providing a solid foundation for designing experiments. The analysis of the students' responses revealed that they were too cautious or hesitant when listing their practical designs. This finding aligns with the argument presented by (Indri et al., 2020) regarding the difficulty of achieving accurate experimental designs that produce meaningful interpretations for future research development. The opposite occurs with the observation indicator, where the N-gain achievement in the industry class is the highest. The first step for students starting a project is to identify observation indicators. The manual presents the phenomenon of food insecurity in Indonesia. Students are then asked to identify problem-solving stimuli that form the basis for project development. This process encourages students to observe and collect relevant facts about potential natural resources and their use as food (Pohan, 2020).

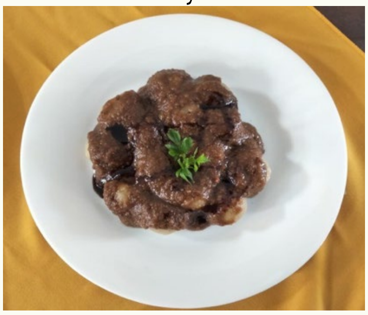
The average N-Gain score in culinary arts class is in the medium-high category. This indicates that culinary arts students can explain their exam answers through the skills they have acquired. However, students still require teacher guidance to acquire the necessary skills during the activity. In the culinary arts class, the processed results substitute flour with a small amount of mole crab flour to emphasize the flavor consistent with the standard recipe. The indicator interprets the lowest n-gain. During the learning process, students are asked to interpret and connect the results of their observations on the potential of natural resources in Bengkulu to address food shortages and malnutrition. The requested keywords are "processing," "access," and "production diversification" of nutrient-rich foods. However, most students in this culinary art class only listed the keywords without providing further explanation. In the context of SPS, interpretation involves understanding data and observations to draw meaningful conclusions. This skill is closely related to predicting and inferring (Firmansyah & Suhandi, 2021). Students often struggle with interpretation because they are unfamiliar with scientific methods and lack experience with experimental setups (Lestari et al., 2020).

Figure 4 shows the nutrient-rich food products made with mole crab flour by the industry and culinary art classes.

Industrial Class

(*risoles*)

Culinary Class



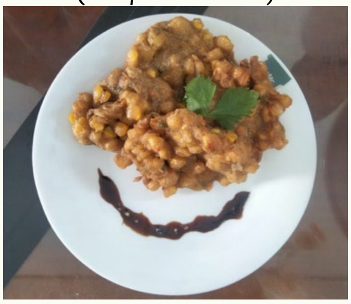
(*cilok*)

Industrial Class

(*tempe mendoan*)

Culinary Class

(*tempe mendoan*)



(*bakwan jagung*)

(*potato chiken kroket*)

(*mie gacoan*)

(*bakwan sayur*)

Figure 4. Variations of processed foods made from mole crab flour

Figure 4 shows the processed food products made by the industrial and culinary arts classes using nutritious mole crab flour. These products are the result of student projects. The projects were carried out as a follow-up to the experimental design indicator. The indicator required students to determine the type of processed food, select nutritious food sources, and choose and understand how to use the necessary tools. During processing, students used mole crab flour. The project steps and materials were agreed upon by the group before carrying out the project to produce eight processed food products. However, based on the teacher's evaluation, some groups were inaccurate in measuring the ingredients, resulting in processed foods that were not quite right.

All processed foods made with mole crab flour have a strong mole crab flavor and aroma. Evaluation of this process indicates that a specific measurement must be established because adding too much can result in an overly savory taste. The advantage is that adding mole crab flour does not spoil the taste of the original recipe, ensuring that the processed food meets quality standards. Selain itu

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pengolahan undur-undur laut atau hewan laut menjadi tepung tidak mengurangi komposisi nutrisinya (Luthfiyana et al., 2022).

Flour made from marine animals, such as mole crabs, has a rich nutritional profile that can benefit the human body. It contains high levels of protein, essential amino acids, and dietary fiber, which makes it ideal for enhancing nutritional value. Ease of digestion and ash content are important factors to consider optimizing its use (Bikker et al., 2020; Sukmiwati et al., 2022).

4. Conclusion

Based on the research conducted, it can be concluded that the manual book for processing animal flour from mole crab is valid, with an average Aiken V score of 0.86 (Valid). This indicates that the manual book can provide students with scientific process skills. Grade XI students in the Industrial and Culinary Art Department at SMKN 7 Kota Bengkulu improved their scientific process skills with the manual book. The Industrial class achieved an average N-gain score of 0.41 in the moderate category, while the Culinary class demonstrated better improvement with an average score of 0.70. The developed manual is capable of imparting scientific process skills to students.

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