



Strengthening Healthy Food Literacy through Education and Culinary Demonstrations of Nutrient-Dense Scrambled Eggs and Fish Nuggets

(Supporting the Implementation of the Free Nutritious Meal Program at SD Negeri
011 Sekupang, Batam)

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Abstract

The implementation of Indonesia's Free Nutritious Meal Program (Makan Bergizi Gratis/MBG) in elementary schools faces a significant challenge in the form of food waste, particularly from vegetable and fish-based menu components. This community service program was conducted at SD Negeri 011 Sekupang, Batam, to strengthen healthy food literacy among students and improve acceptance of nutritious foods through an integrated educational and culinary intervention. The program was considered important because nutritional literacy is a key determinant of healthy eating behavior and directly influences the effectiveness of school feeding programs. The intervention combined visual education on the "Isi Piringku" (My Plate) balanced nutrition guidelines with interactive culinary demonstrations using a Functional Gastronomy approach. Students participated in educational sessions, discussions, sensory evaluations, and demonstrations of Homemade Healthy Fish Nuggets and Nutrient-Dense Vegetable Scrambled Eggs prepared from locally available ingredients. Program effectiveness was measured through pre-test and post-test questionnaires, plate-waste observations, and organoleptic evaluations. The results revealed a substantial improvement in students' nutritional knowledge, with average scores increasing by 96.02% from pre-test to post-test. Furthermore, 95% of participating students consumed the modified food products completely, indicating a significant enhancement in sensory acceptance. The findings demonstrate that combining nutrition literacy with sensory-oriented culinary innovation can effectively reduce food refusal and encourage healthier eating behaviors among children. This approach offers a practical model for optimizing the impact of the MBG program while supporting the development of sustainable healthy eating habits in school communities.

Keywords: *Nutritional Literacy, Free Nutritious Meal Program, Food Waste Reduction, Functional Gastronomy, Healthy School Meals, Sensory Acceptance.*

INTRODUCTION

Developing human resource quality is a foundational pillar in achieving the strategic vision of Indonesia Gold 2045 or known as Indoneia Emas 2045(Purnomo et al., 2025). A





critical determinant in fostering an exceptional future generation is meeting optimal nutritional needs during early childhood, particularly in primary school-aged children. Elementary school students experience a rapid linear growth spurt alongside a golden phase of cognitive development. During this stage, brain cells require balanced macro- and micronutrient intake to facilitate synaptic transmission, cognitive retention, and learning concentration in the classroom.

As a concrete national intervention, the Indonesian government has massively initiated the Free Nutritious Meal (MBG) program, targeting millions of students across the archipelago. (Widyatmoko et al., 2025) At a macro level, the MBG program is designed not only as a social protection instrument but also as a biomedical intervention to break the cycle of malnutrition, suppress stunting prevalence, and improve students' academic performance. (Restiana, 2025) Although the supply of nutritious food is guaranteed free of charge through the Nutrition Fulfillment Service Units (SPPG), the mere physical availability of food does not automatically guarantee healthy consumption behavior in children unless paired with adequate nutritional literacy. Nutrition served on a plate yields no biological benefits if students refuse to consume it and tend to leave plate waste. Therefore, physical food provision must be integrated with holistic healthy food literacy education to instill sustainable healthy dietary habits early within the school ecosystem.

Numerous studies indicate that school-based nutritious food provision contributes to improved nutritional status, health, learning motivation, and academic achievement (Nurin Eyes, Imam Erwin Nadia, n.d.). Furthermore, this program is viewed as part of educational transformation and a long-term investment toward realizing the Indonesian Gold Generation 2045 or Indonesia Emas 2045. Nevertheless, the program's success depends heavily on sustainable nutrition education. Nutritional literacy shapes the understanding of students and families regarding healthy eating patterns, safe ingredient selection, and the application of balanced nutrition principles. Early-stage nutrition education has proven effective in increasing children's awareness regarding diverse, nutritious, balanced, and safe food intake.

In this context, the Balanced Nutrition Guidelines established by the Ministry of Health of the Republic of Indonesia (Regulation No. 41 of 2014) serve as a crucial foundation for school nutrition education. One implementation is the "Isi Piringku" (My Plate) concept, which provides a practical blueprint for the optimal proportions of staple foods, side





dishes, vegetables, and fruits in every meal. Implementing these guidelines is expected to bolster the nutritional status of students and amplify the long-term (Peraturan Menteri Kesehatan Republik Indonesia Nomor 41 Tahun 2014 Tentang Pedoman Gizi Seimbang, 2014) impact of the MBG program. (Hasibuan et al., 2025)

Literature Review and Scientific Novelty

Studies and community service activities concerning school nutrition implementation have widely focused on various intervention models. (Ayuningtiyas et al., 2023) highlighted that the visual "Isi Piringku" campaign initiated by the Ministry of Health significantly improves conceptual nutritional knowledge in children. However, a weakness of purely cognitive-visual interventions is the low conversion rate of knowledge into actual practice at the school dining table; children tend to memorize the plate graphics but maintain picky eating habits during lunchtime. Similarly, Syafii et al. (2024) conducted nutrition education combined with booklet distributions, which improved theoretical awareness but lacked interactive culinary demonstrations, leaving students struggling to accept healthy foods that tasted foreign to them.

Conversely, research on specific animal protein sources was advanced by (Obar et al., 2023) Obar et al. (2023) through the "Healthy with Eggs" (SETEL) movement for stunting prevention. While effective in improving nutritional status, its focus was limited to a single, monotonous commodity and missed the integration of marine fish processing, which is rich in Omega-3 fatty acids essential for cognitive development. This comparative literature review exposes a practical and scientific gap that establishes the novelty of this community service project. The innovation of this study lies in the simultaneous amalgamation of three student-centered intervention pillars that have not been integrated in prior research:

- i. Real-time synchronization between literacy materials and the active operation of the government's MBG program, making the education immediately applicable and directly motivating students to finish their daily meals provided by the SPPG.
- ii. Active In-Class Learning intervention, targeting students as agents of change through interactive visual media and direct sensory food exposure.
- iii. Application of a School Functional Gastronomy approach, reconstructing children's favorite foods (nuggets and scrambled eggs) using high-Omega-3 local marine catches from the Riau Islands through healthy processing techniques (free of





artificial preservatives and low in oil) to evaluate students' direct organoleptic responses.

Main Problems of the Partners (Field Assessment)

Based on initial assessments, observations, and in-depth interviews with school management and teachers at SD Negeri 011 Sekupang, Batam, several core problems hindering school nutritional intervention were identified. SD Negeri 011 Sekupang is a public elementary school managed by the local government, located on Jalan Gajah Mada, Taman Sari Hijau Housing, Tiban Baru, Sekupang, Batam, Riau Islands. Operating under a "B" accreditation (BAN-SM No. 1339/BAN-SM/SK/2019), the school spans 3,059 m² and features adequate infrastructure, including internet access and state electricity (PLN). Its close proximity to the Batam Tourism Polytechnic provides an excellent avenue for academic collaboration in Tri Dharma Tripartite Higher Education activities, building upon previous educational engagements. Previously similar activities being implemented which related to specific program on nutritious education (Gunawan et al., 2026)

A shared critical concern is upgrading school-age nutritional quality through sustainable assistance. However, in the field implementation of the SPPG-backed MBG program, high rates of food refusal and food waste were observed in specific menu components. Although the provided bento meals scientifically met balanced requirements (carbohydrates, animal protein, plant protein, vegetables, and fruit), a majority of students refused to finish the vegetables and marine fish side dishes.

The students lacked an understanding of the biological correlation between these nutrients and their health or intelligence. Furthermore, children's taste preferences have been heavily influenced by commercial street foods high in sugar, salt, and fat (GGL), making healthy preparations like fried fish and clear vegetable soups seem bland and unappealing. Consequently, vegetables and fruits were frequently left untouched in bento boxes, establishing a critical need for academic intervention to boost healthy food literacy directly among students. (Husni Wildani, Utami, Shalahuddin & Prima Mulya, 2026)

Objectives of the Program

Addressing the aforementioned issues, this community service initiative led by lecturers and students of Batam Tourism Polytechnic specifically aimed to:
Increase healthy food literacy and visual comprehension of "Isi Piringku" balanced nutrition principles among students, measured through pre- and post-intervention knowledge





scores. Minimize food waste within the school's MBG program by shifting students' perceptions, interests, and attitudes toward consuming vegetables and marine fish. Enhance student awareness regarding the biological urgency of animal proteins (especially fish and eggs) for cognitive development, physical growth, and immune defense. Foster sustainable healthy consumption behavior, bridging school meal programs with healthy dietary habits in the family environment.

Provide practical skills in processing affordable, locally-sourced healthy side dishes via demonstrations of Healthy Fish Nuggets (Kresnasari et al., 2019) and Nutrient-Dense Vegetable Scrambled Eggs that can be easily replicated at home. Additionally, this program benefits the academic community by fostering institutional collaboration between culinary management scholars and primary education facilities, sharpening faculty skills in community-directed scientific applications, and serving as a publication platform for academic output.

METHODOLOGY

Location and Target Partners

The community service activity was conducted at SD Negeri 011 Sekupang, Batam, Riau Islands. The intensive intervention targeted 6th-grade students, selected as they represent a critical age for developing logical reasoning and autonomy over food choices. Field execution, data collection, and initial observations occurred from May 11 to 13, culminated by the main educational and culinary demonstration session on Friday, May 15, 2026.

Instruments

To measure intervention efficacy and student literacy achievements, three primary instruments were utilized:

1. Student Nutritional Literacy Questionnaire (Pre-test & Post-test): Comprising 10 child-friendly multiple-choice questions designed to assess student understanding of "Isi Piringku" balanced portions, the role of animal proteins in brain function, and the risks of unhealthy snacks.
2. Plate Waste Observation Sheet (Visual Comber Waste Estimation): A visual scale instrument to measure the percentage of food waste left by students in their MBG





bento boxes before and after the literacy education, focusing on vegetables and fish components.

3. Children's Organoleptic Evaluation Form: A sensory evaluation sheet utilizing a facial emoticon hedonic scale to measure student acceptance regarding the taste, aroma, and texture of the demonstrated modified dishes.

Data Collection and Analysis

Quantitative data were obtained via pre-test questionnaires administered right before the session and post-test forms distributed at the conclusion of the event. Food waste observations were gathered participatively by student team members (Muhammad Syauqan Rizieq, Eko Lamendri, and Egi Dio Aprilian) who documented and calculated the remaining contents of students' lunch bento boxes. Cognitive data were evaluated using comparative descriptive analysis to track the percentage increase in student comprehension.

Intervention Workflow

The structured intervention followed four systematic phases:

- Phase I (Preparation & Baseline Assessment): Formal coordination with 6th-grade teachers and the SPPG team to align literacy materials with the active MBG menu cycle, while observing baseline plate-waste behavior.
- Phase II (Face-to-Face Education): Classroom instruction delivered to 6th graders. Pre-tests were completed first, followed by an engaging lecture on "Isi Piringku" principles, the value of fish proteins, and the dangers of unhygienic snacks.
- Phase III (Interactive Q&A and Student Reflection): An open dialogue where students shared their challenges regarding vegetable and fish consumption, and received practical tips to enjoy healthy foods.
- Phase IV (Culinary Demonstration & Sensory Evaluation): Culinary Management faculty demonstrated healthy processing of local marine fish and eggs into Homemade Fish Nuggets and Nutrient-Dense Vegetable Scrambled Eggs. The phase concluded with student taste-testing, organoleptic scoring, and post-test completion.





RESULTS AND DISCUSSION

Scientific Findings

The field intervention yielded significant scientific findings. Crucially, it revealed that students' resistance to marine fish and vegetables in the MBG program did not stem from biological organoleptic rejection (the intrinsic flavor of the ingredients) but rather from a **sensory literacy gap** combined with **culinary monotony** in preparation.

Prior to intervention, baseline food waste data from the MBG bento boxes showed that 65% of students left vegetables behind and 45% left standard fried fish provided by the catering unit. Student feedback indicated that a pungent fishy odor and a soggy vegetable texture were the main turn-offs. However, when the menu was reconstructed through a functional gastronomy demonstration transforming the exact same raw ingredients into structurally modified foods—namely *Homemade Fish Nuggets* (steamed, minced fish mixed with grated carrots and coated in breadcrumbs) and *Nutrient-Dense Vegetable Scrambled Eggs* (finely minced spinach incorporated into an egg emulsion matrix)—a drastic shift occurred.

Based on independent organoleptic testing (10 sample pax of the modified dishes), 95% of the students completely finished the modified dishes and rated the fish nugget taste as highly delicious. This scientifically demonstrates that altering the physical food architecture (food structural modification) can successfully manipulate visual and tactile perceptions (visual-sensory masking), rendering initially rejected nutritious commodities appealing to children.

Furthermore, the interactive educational approach proved highly effective in elevating cognitive scores. The comparative analysis of pre-test and post-test scores is detailed in

Table 1. Distribution of Student Balanced Nutrition Knowledge Scores Before and After Intervention

Target Group	Average Pre-test Score	Average Post-test Score	Cognitive Growth Percentage	Minimum Target Achievement
6th-Grade Students	45.20	88.60	96.02%	At least 70% of students show improvement

Source: Processed Data, 2026.





The empirical data in Table 1 proves that combining direct instruction with "Isi Piringku" visual aids and culinary simulations yields a substantial leap in conceptual mastery, far exceeding the initial internal benchmark.

Scientific Discussion on Behavioral Modification Mechanisms

The practical culinary demonstration featured two healthy menu models designed for simple replication:

a. Homemade Healthy Fish Nuggets

Designed as a strategy to elevate child fish consumption through a familiar, high-appeal format.

- Main Ingredients: Local fish (mackerel/mackerel tuna), eggs, wheat/corn starch, grated carrots, garlic, and a pinch of salt.
- Healthy Processing: The fish is pre-steamed to preserve micro-nutrients; the dough is steamed before portioning, and final cooking uses an air fryer, baking, or flash frying with minimal oil. (Apriadi & Rosalina, 2024)
- Educational Value: Rich source of protein and brain-supporting Omega-3 fatty acids, prepared entirely without artificial preservatives or excessive MSG. It is also significantly more economical than commercial instant options.

b. Nutrient-Dense Vegetable Scrambled Eggs

A budget-friendly, high-efficiency option easily replicated by parents at home.

- Main Ingredients: Chicken eggs, grated carrots, finely chopped spinach, scallions, garlic, and salt.
- Healthy Processing: Utilizes non-stick pans with minimal oil, or alternative healthy steaming methods.
- Educational Value: Delivers high-quality egg protein combined with dietary fiber and vitamins from hidden vegetables, solving the challenge of vegetable refusal. (Fitri Yulistya & Saputra, 2025)





Figure 1. Educational Poster: Signature Healthy Menu, 2026

Theoretically, childhood food preferences are strongly dictated by social learning theory and sensory environmental exposure. The sharp rise in local fish acceptance following the demonstration can be explained biochemically. Local marine fish from Batam possess high levels of polyunsaturated fatty acids (Omega-3), which are highly sensitive to thermal oxidation. Standard catering methods that deep-fry fish excessively trigger the release of volatile compounds like trimethylamine, creating a pungent fishy odor that causes instant olfactory rejection in children.

In our functional culinary demonstration, the *Homemade Fish Nuggets* utilized a pre-steaming technique with an aromatic garlic seasoning matrix. Steaming at a controlled temperature denatures the protein structure without oxidizing the delicate Omega-3 fatty acids, binding the trimethylamine compound and preventing it from vaporizing into an offensive odor. Additionally, adding grated carrots introduces a fiber matrix that increases water-holding capacity, keeping the interior juicy while the breadcrumb exterior remains crispy even under low-oil cooking. This structural texture contrast stimulates dopamine release in the child's sensory reward centers, creating a positive consumption experience.

For the *Nutrient-Dense Vegetable Scrambled Eggs*, the governing chemical principle is bitterness masking. Spinach naturally contains alkaloids and oxalic acid, which register as bitter or astringent on the tongue—a sensation to which children's taste receptors are far more sensitive than adults. By finely mincing the spinach and suspending it within the colloidal lipid matrix of chicken eggs (which are rich in lecithin), the egg lipids coat the oxalic





acid molecules. Upon ingestion, the egg lecithin prevents direct contact between the bitter vegetable compounds and the tongue's papillae, masking bitterness with the natural savory flavor (*umami*) of egg fats. This practical solution effectively delivers dietary fiber without inducing physical aversion.

Strategic Realization

The outcomes achieved focus on maximizing MBG program efficiency by shifting how meals are perceived—repositioning them from mere nutritional distribution channels into vital tools for health education and lifestyle character building. This approach ensures continuity between school meals and dietary habits practiced at home.



Figure 2. Photo Community Service Educational Activities at SDN 011 Sekupang, 2026.





Figure 3. Program Workflow Framework - Source: Processed Data, 2026

Comparative Analysis with Prior Programs

Compared to the community service work by (Rahmah et al., 2025) , which evaluated free school lunch programs purely from an administrative standpoint without active culinary interventions, their findings showed a persistent plate waste rate exceeding 30%. This confirms that top-down nutritional provision is highly susceptible to biological delivery failure if student organoleptic preferences are overlooked.

Similarly, the work of (Program et al., 2026; Syafii et al., 2024) and also study by (Roos, 2025) succeeded in elevating cognitive knowledge, yet failed to reduce vegetable leftovers because their method lacked a sensory-adaptive culinary bridge. The Batam Tourism Polytechnic team effectively bridged this gap, proving that classroom-level culinary restructuring can spark intrinsic motivation in students to clear their plates, thereby directly supporting their health and learning performance. Implementing methodological emphasis by merging targeted literacy with real-time cooking modifications, this program delivers sustainable educational material (via distributed literacy booklets, school posters, and media tools) while reinforcing a cooperative network among the school, parents, and the SPPG unit

Achieved Results and Prospects for Sustainability

Achieved Results





The community service initiative successfully generated several key outcomes that directly optimized the implementation of the government's Free Nutritious Meal (MBG) program at SD Negeri 011 Sekupang.

- i. The project drove a profound shift in how the school community perceives the MBG program. Rather than being viewed merely as a routine food distribution channel, the meals are now understood as an institutional tool for health education and healthy lifestyle character building. (Sehat & Berprestasi, 2019)
- ii. The initiative produced and distributed a suite of permanent educational resources to ensure long-term learning. These tangible media assets include Healthy Food Literacy Booklets, which serve as practical guides for students and teachers and Educational Posters placed strategically within the school environment to reinforce healthy eating habits visually. These socialization Materials designed to be utilized continuously for ongoing school health campaigns. (Siagian & Tampubolon, 2009)

Prospects for Sustainability

To ensure these positive behavioral modifications do not diminish over time, a sustainable, multi-stakeholder collaboration mechanism has been established. A communication and periodic evaluation network now links the school administration, the local Nutrition Fulfillment Service Unit (SPPG), and the students' parents. This network allows all parties to monitor student acceptance, track menu rotations, and collectively manage the ongoing execution of the MBG program. (Widyatmoko et al., 2025) Furthermore, the Batam Tourism Polytechnic team has mapped out a phased institutional commitment to guarantee programmatic continuity. Faculty members spanning various hospitality and culinary disciplines will be deployed in subsequent community service (PKM) cycles. Future interventions will focus on mentoring the management of a healthy school canteen (Amalia et al., 2024; Simbolon et al., 2025) and establishing a routine monitoring schedule alongside teachers and the SPPG. This rigorous, ongoing oversight ensures that the transition toward a healthy food consumption culture remains consistent, ultimately fostering a healthier, highly competitive, and resilient younger generation in Batam.

Analysis of Supporting and Inhibiting Factors of the Project





The execution of this community service (PKM) project involved various dynamics in the field. Identifying these supporting and inhibiting factors provides valuable insights for the optimization of future school-based nutritional interventions.

1. Supporting Factors (*Faktor Pendukung*)

The successful implementation and high achievement of this project's targets were accelerated by several key driving factors:

- i. High Institutional Synergy: Exceptional collaboration between academia (Batam Tourism Polytechnic's Culinary Management Study Program and PUSLITABMAS), the primary education sector (SD Negeri 011 Sekupang), and the government's food logistics unit (SPPG Sekupang) created a highly coordinated operational flow.
- ii. Active Partnership with School Management: The Headmaster and the 6th-grade teachers showed immense enthusiasm and provided open access to school facilities. They actively assisted the team during the pre-test, post-test, and observational phases, ensuring high student discipline during the sessions.
- iii. Student Enthusiasm and Peer Dynamics: The target students exhibited high curiosity during the *Active In-Class Learning* phase and cooking demonstrations. The visual-sensory attraction of tasting the newly modified foods created positive peer reinforcement, motivating hesitant children to clear their bento boxes completely without leaving leftovers.
- iv. Resource Readiness: The availability of well-prepared, child-friendly educational materials (such as posters and literacy booklets) greatly simplified the delivery of abstract nutritional concepts, allowing them to be easily understood by primary school students.

2. Inhibiting Factors (*Faktor Penghambat*)

Despite the overwhelmingly positive outcomes, the project team had to navigate certain field constraints:

- i. Deep-Rooted Dietary Addictions: A primary challenge was the students' pre-existing addiction to commercial street foods sold outside the school vicinity. These snacks are heavily loaded with high sugar, salt, and fat (GGL), (Amalia et al., 2024) which has conditioned the children's taste preferences over time. Consequently, changing their initial perception that healthy school lunch components—such as fish and





vegetables—are "bland" or "unappealing" required a rigorous sensory re-education effort.

- ii. Time Constraints within the School Schedule: Delivering a comprehensive program that simultaneously included baseline plate-waste monitoring, cognitive counseling, a live interactive cooking demonstration, and organoleptic tasting within the tight constraints of the school's active Friday schedule presented a major logistical challenge.
- iii. Operational Variations in Bulk Catering: Aligning the delicate structural masking techniques introduced during the live demonstration with the high-volume, standardized catering production managed daily by the SPPG presents an ongoing bottleneck for seamless, large-scale implementation

CONCLUSION

1. This community service initiative by the Batam Tourism Polytechnic successfully delivered practical and scientific contributions to the government's Free Nutritious Meal (MBG) program at SD Negeri 011 Sekupang, Batam. The educational-participatory framework resolved school-level plate waste challenges while generating a 96.02% surge in student balanced nutrition literacy.
2. The scientific findings confirm that food structural engineering via *Homemade Fish Nuggets* and *Nutrient-Dense Vegetable Scrambled Eggs* effectively masks offensive fishy aromas and bitter vegetable notes through visual-sensory masking principles, significantly upgrading organoleptic acceptance among primary school students.(Firdausiyah et al., 2025)
3. To ensure long-term sustainability, it is recommended that the school permanently integrate the distributed booklets and posters into its health education curriculum. Moving forward, subsequent community service cycles will deploy multi-disciplinary faculties to assist in monitoring healthy school canteens and establish periodic review mechanisms with teachers and the SPPG, ensuring a seamless, consistent transition toward healthy eating cultures for a brighter, healthier generation in Batam.

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