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From Meal Acceptance to Plate Waste Reduction: An Integrated School Nutrition Promotion Framework for Indonesia's Free Nutritious Meal Program

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To cite this article: Aji, P.T. & Rizkasari, E. (2026). From Meal Acceptance to Plate Waste Reduction: An Integrated School Nutrition Promotion Framework for Indonesia's Free Nutritious Meal Program. *International Journal of Education and Learning Studies*, 2(2), 144-165. <https://doi.org/10.64421/ijels.v2i2.104>

Articles Information

Received : 31-07-2026

Revised : 23-08-2026

Accepted : 28-08-2026

Published : 30-08-2026

Abstract

School feeding programs require integrated strategies that address both food provision and children's eating behaviours to improve meal acceptance and reduce plate waste. This study aimed to formulate an Integrated School Nutrition Promotion Framework within Indonesia's Free Nutritious Meal Program (MBG). A Design-Based Research approach was conducted through five phases: needs assessment, framework design, expert validation, pilot implementation, and refinement. The study involved 70 participants from five public primary schools, including students, teachers, school personnel, and parents. Data were collected through questionnaires, interviews, observations, and document analysis, while content validity was assessed using the Content Validity Index. The findings identified six interrelated components: nutrition literacy, teacher engagement, active learning, peer support, parental engagement, and a supportive school food environment. Expert evaluation demonstrated excellent content validity (S-CVI/Ave = 0.97), while pilot implementation indicated that the framework was feasible for integration into school routines and supported stakeholder engagement in nutrition promotion activities. Unlike approaches that address nutrition education or food provision separately, this framework integrates educational, behavioural, social, and environmental dimensions within a unified whole-school approach. The framework provides a context-responsive strategy for improving meal acceptance, reducing plate waste, and strengthening the sustainability of school feeding programs.

Keywords: School Nutrition Promotion; Whole-School Nutrition; Meal Acceptance; Plate Waste; Behaviour Change

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Author Contributions: Prima Trisna Aji: Conceptualization, Methodology, Investigation, Formal Analysis, Data Curation, Writing – Original Draft. Elinda Rizkasari: Conceptualization, Supervision, Writing – Review & Editing.

Funding Statement: This research received no external funding.

Ethical Approval / IRB Statement: Formal ethical approval was not obtained for this study. Participation was voluntary, and informed consent was obtained from all participants.

Informed Consent Statement: Informed consent was obtained from all adult participants. Written parental consent and child assent were obtained for all participating students.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to participant privacy and confidentiality.

Conflicts of Interest: he authors declare no conflicts of interest.

Generative AI Use Statement: Disclose any use of generative AI tools or state "Not applicable."

1. INTRODUCTION

School feeding programs have become one of the most important public health and educational interventions implemented worldwide. Beyond addressing hunger and improving children's nutritional status, school meal programs contribute to enhancing learning readiness, academic achievement, school attendance, cognitive development, and children's long-term health outcomes (Bundy et al., 2018; Drake et al., 2020; World Food Programme [WFP], 2022). As schools represent one of the few settings capable of consistently reaching nearly all children during their formative years, school feeding programs are increasingly recognized as strategic platforms for establishing healthy eating habits, reducing health inequalities, and supporting sustainable human development (Food and Agriculture Organization [FAO], 2019; World Health Organization [WHO], 2021). Consequently, many countries have expanded school meal initiatives as part of broader investments in education, nutrition, and social protection (UNICEF, 2021).

Despite their recognized benefits, the effectiveness of school feeding programs is often constrained by implementation challenges that extend beyond food provision. One of the most persistent issues is low meal acceptance, in which children refuse, selectively consume, or fail to finish the meals provided. This phenomenon subsequently contributes to plate waste, leading to reduced nutritional intake, inefficient utilization of public resources, increased environmental burdens, and substantial food losses (Byker Shanks et al., 2017; Silvennoinen et al., 2019). Importantly, these challenges indicate that the success of school feeding programs depends not only on the nutritional quality of meals but also on children's willingness to consume them. Studies have consistently shown that improving meal acceptance is essential for maximizing the nutritional effectiveness and cost-efficiency of school feeding programmes (Cohen et al., 2021; Steenhuis et al., 2021).

Previous studies have predominantly focused on improving menu quality, nutrient composition, food safety, menu diversity, and food service management (Cohen et al., 2021; FAO, 2022). Although these aspects are essential, they do not sufficiently explain why children choose to consume or reject school meals. Eating behaviour among primary school students is shaped by multiple interacting determinants, including nutrition knowledge, taste preferences, food familiarity, peer influence, teacher encouragement, parental practices, classroom culture, and the broader school food environment (Story et al., 2008; Townsend & Foster, 2013; Vaughn et al., 2018). Therefore, interventions that focus solely on food provision are unlikely to maximize programme effectiveness without simultaneously addressing the educational, behavioural, and social factors influencing children's eating practices.

In response to the growing importance of child nutrition, the Government of Indonesia has introduced the Free Nutritious Meal Program (Program Makan Bergizi Gratis/MBG) as a national strategy to improve children's nutritional status, strengthen educational outcomes, and support the development of high-quality human resources. As one of the largest school nutrition initiatives in Indonesia, MBG represents a substantial public investment and reflects the government's commitment to integrating nutrition with educational development. The programme is also aligned with global commitments to the

Sustainable Development Goals, particularly those related to ending hunger, improving health, ensuring quality education, and reducing inequalities (United Nations, 2015). However, the success of MBG cannot be measured solely by the number of meals distributed. Rather, its effectiveness ultimately depends on whether students willingly consume the meals provided and whether the programme succeeds in fostering healthier eating behaviours while minimizing food waste in schools.

The implementation of MBG therefore requires more than operational excellence in food procurement and distribution. Schools need evidence-informed strategies that encourage children to accept nutritious meals, establish positive eating habits, and create supportive school environments that reinforce healthy dietary behaviours. Contemporary school health promotion emphasizes that sustainable behaviour change requires coordinated involvement from multiple stakeholders, including teachers, parents, school leaders, peers, and the wider school community (WHO, 2021; Langford et al., 2015). Nevertheless, these components are frequently implemented independently, resulting in fragmented interventions that reduce the overall effectiveness and sustainability of school nutrition programmes.

To date, there remains limited evidence regarding an integrated framework that systematically combines nutrition promotion, health education, behaviour change strategies, active learning, teacher engagement, parental support, peer influence, and supportive school food environments to optimize meal acceptance and reduce plate waste among primary school students. Existing interventions generally examine individual determinants or programme components separately, with relatively little attention devoted to how these elements interact within a comprehensive implementation model (McLoughlin et al., 2020; Nathan et al., 2021). This evidence gap is particularly important in the context of Indonesia's MBG programme, where achieving sustainable behavioural change is equally important as ensuring nutritional provision.

Therefore, this study proposes an Integrated School Nutrition Promotion Framework for Optimizing Meal Acceptance and Reducing Plate Waste among Primary School Students. The proposed framework provides an evidence-informed approach that integrates educational, behavioural, and health promotion perspectives into a unified implementation model. By positioning schools as active environments for nutrition promotion rather than merely food distribution, the framework is expected to improve children's acceptance of nutritious meals, reduce plate waste, strengthen healthy eating behaviours, and support the long-term sustainability of school nutrition programmes in Indonesia and other comparable educational contexts.

2. LITERATURE REVIEW

2.1. School Nutrition Promotion and School Feeding Programs

School feeding programs have evolved from food assistance initiatives into comprehensive school-based interventions that simultaneously address nutrition, education, health, and social protection. Beyond alleviating short-term hunger, well-designed school meal programmes contribute to improving children's nutritional status, cognitive development, school participation, learning readiness, and psychosocial well-

being (Kristjansson et al., 2016; UNESCO, 2024). Increasingly, schools are recognized as ideal settings for health promotion because they provide continuous opportunities for repeated food exposure, nutrition education, and the development of lifelong healthy eating habits within structured learning environments (Centers for Disease Control and Prevention [CDC], 2019; WHO Regional Office for Europe, 2021). Consequently, effective school feeding programmes should extend beyond ensuring the availability of nutritious meals to creating educational and environmental conditions that encourage children to consume them consistently.

The concept of school nutrition promotion has therefore expanded from a food-centred perspective toward a whole-school approach that integrates curriculum, school policies, health services, family participation, and community engagement. This perspective is consistent with the Health Promoting Schools approach, which emphasizes that students' health behaviours are shaped through coordinated actions involving multiple stakeholders and institutional systems rather than isolated educational activities (International Union for Health Promotion and Education [IUHPE], 2022). Within this framework, nutrition education is most effective when embedded within supportive school cultures that encourage healthy food choices through daily routines, positive social interactions, and consistent behavioural reinforcement.

Evidence increasingly indicates that providing nutritious meals alone does not guarantee improved nutritional outcomes. Children's eating behaviours are influenced by a complex interaction of cognitive, behavioural, social, cultural, and environmental determinants that extend well beyond food availability (Haines & O'Brien, 2022; Rasmussen et al., 2006). Contemporary school nutrition interventions therefore incorporate strategies such as nutrition education, teacher facilitation, experiential learning, peer modelling, parental involvement, and supportive food environments to strengthen healthy dietary behaviours and improve programme effectiveness (McIsaac et al., 2019; Wolfenden et al., 2021). These multidimensional interventions acknowledge that healthy eating is a learned and socially constructed behaviour that develops through repeated interactions among individuals and their surrounding environments.

The shift toward integrated school nutrition promotion is further reinforced by growing international commitments to creating sustainable, equitable, and health-promoting school food systems. Recent global initiatives advocate comprehensive approaches that connect nutrition, education, environmental sustainability, and child development while encouraging schools to become active agents of behaviour change rather than passive providers of meals (FAO & WFP, 2024; UNESCO, 2024). Accordingly, school nutrition promotion should be conceptualized as a comprehensive ecosystem in which educational practices, stakeholder collaboration, institutional leadership, and supportive school environments operate synergistically to enhance children's dietary behaviours and maximize the long-term benefits of school feeding programmes.

2.2. Meal Acceptance and Plate Waste in Primary Schools

Meal acceptance has become one of the principal indicators for evaluating the effectiveness of school feeding programs because it reflects students' willingness to consume the meals provided rather than merely

receiving them. High meal acceptance indicates that school meals successfully meet students' nutritional needs while supporting the intended educational and health objectives of school feeding programmes. Conversely, low meal acceptance often results in unfinished meals and reduced dietary intake, thereby limiting nutritional benefits and diminishing programme effectiveness (Cohen et al., 2023; Harvard T.H. Chan School of Public Health & Chef Ann Foundation, 2024). Consequently, meal acceptance has increasingly been recognized as a critical behavioural outcome in evaluating school nutrition interventions.

27 Evidence suggests that meal acceptance is influenced by a complex interaction of individual, social, and environmental factors rather than food quality alone. Children's food preferences, sensory perceptions, familiarity with menu items, eating self-efficacy, peer interactions, teacher encouragement, meal duration, and the overall dining atmosphere all contribute to their willingness to consume school meals (Fildes et al., 2019; Nekitsing et al., 2018; Reicks et al., 2019). Furthermore, repeated exposure to healthy foods, positive mealtime experiences, and supportive social environments have been shown to increase children's acceptance of unfamiliar foods and encourage healthier eating behaviours over time (Appleton et al., 2016; Birch & Ventura, 2009). These findings indicate that improving meal acceptance requires comprehensive strategies that integrate nutrition education, behavioural support, and environmental facilitation rather than relying exclusively on improvements in menu quality or food service.

28 Plate waste has likewise emerged as an essential indicator of programme efficiency, nutritional effectiveness, and environmental sustainability. Food that remains uneaten represents not only lost nutritional opportunities for children but also unnecessary expenditure of financial resources, labour, water, energy, and agricultural inputs throughout the food supply chain (United Nations Environment Programme [UNEP], 2021). Within school feeding programmes, excessive plate waste undermines both public health goals and sustainable food system objectives, highlighting the need for interventions that address food consumption alongside food provision (School Meals Coalition, 2023).

41 Recent international studies have therefore shifted from food-centred interventions toward integrated approaches that combine nutrition education, behavioural change strategies, supportive school food environments, and stakeholder engagement to simultaneously improve meal acceptance and reduce plate waste (Alderman & Bundy, 2024; Jones et al., 2022; Swensson & Tartanac, 2020). Such approaches recognize that children's eating behaviours are shaped by interactions among schools, families, peers, and institutional environments. Accordingly, successful school nutrition programmes should move beyond ensuring food availability toward fostering positive eating behaviours that maximize nutritional intake while minimizing food waste.

2.3. Research Gap and Proposed Framework

15 18 Indonesia's Free Nutritious Meal Program (Program Makan Bergizi Gratis/MBG) represents a major national investment in improving children's nutritional status and educational outcomes. Nevertheless, the long-term success of the program depends not only on effective food distribution but also on students' willingness to consume the meals provided. Current discussions on MBG have highlighted the importance of meal quality, implementation systems, and governance; however, limited attention has been given to

integrated school-based strategies that encourage children to accept nutritious meals while reducing plate waste.

Existing literature predominantly examines nutrition education, school meal acceptance, plate waste, teacher involvement, or parental participation as separate intervention domains. Few studies have integrated these determinants into a comprehensive framework capable of guiding nutrition promotion within school feeding programs. Accordingly, there remains a need for an evidence-based framework that connects nutrition literacy, active learning, teacher support, peer influence, parental engagement, and supportive school food environments into a coherent model for optimizing meal acceptance and minimizing plate waste among primary school students. Based on this gap, the present study proposes An Integrated School Nutrition Promotion Framework for Optimizing Meal Acceptance and Reducing Plate Waste among Primary School Students, which is expected to provide both a conceptual contribution to school health promotion literature and a practical implementation framework for strengthening the MBG program in Indonesia.

3. METHOD

3.1. Research Design

This study employed a Design-Based Research (DBR) approach to develop and validate an Integrated School Nutrition Promotion Framework for optimizing meal acceptance and reducing plate waste among primary school students. DBR was selected because it enables the systematic integration of theoretical knowledge, empirical evidence, and stakeholder experiences through iterative cycles of analysis, design, validation, implementation, and refinement. The study consisted of five interconnected phases: (1) needs assessment, (2) framework design, (3) expert validation, (4) pilot implementation, and (5) framework refinement. The final output was an evidence-informed framework intended to guide the implementation of school nutrition promotion within the Indonesian Free Nutritious Meal Program (MBG).

3.2. Participants

The study was conducted in five public primary schools in Surakarta, Central Java, Indonesia. The selected schools had established school meal services and school-based nutrition activities, providing an appropriate context for developing and evaluating the proposed nutrition promotion framework. Schools were selected purposively to represent typical urban primary school settings with ongoing nutrition promotion practices. A total of 70 participants were recruited through purposive sampling based on their direct involvement in school nutrition activities. The participants consisted of 20 classroom teachers, 20 parents, 20 primary school students from Grades 4–6, and 10 school leaders, comprising five principals and five teachers responsible for school health and student welfare activities. In addition, 3 experts specializing in primary education, nutrition, health promotion, public health, educational psychology, and child development participated in the expert validation phase.

3.3. Research Procedure

The study followed a Design-Based Research (DBR) approach consisting of five iterative phases (Figure 1). The process began with a needs assessment to identify existing school nutrition promotion practices, factors influencing meal acceptance, and issues related to plate waste through questionnaires, interviews, observations, and document analysis. The findings informed the design of the preliminary Integrated School Nutrition Promotion Framework, which was developed by integrating empirical evidence with relevant literature and theoretical perspectives.

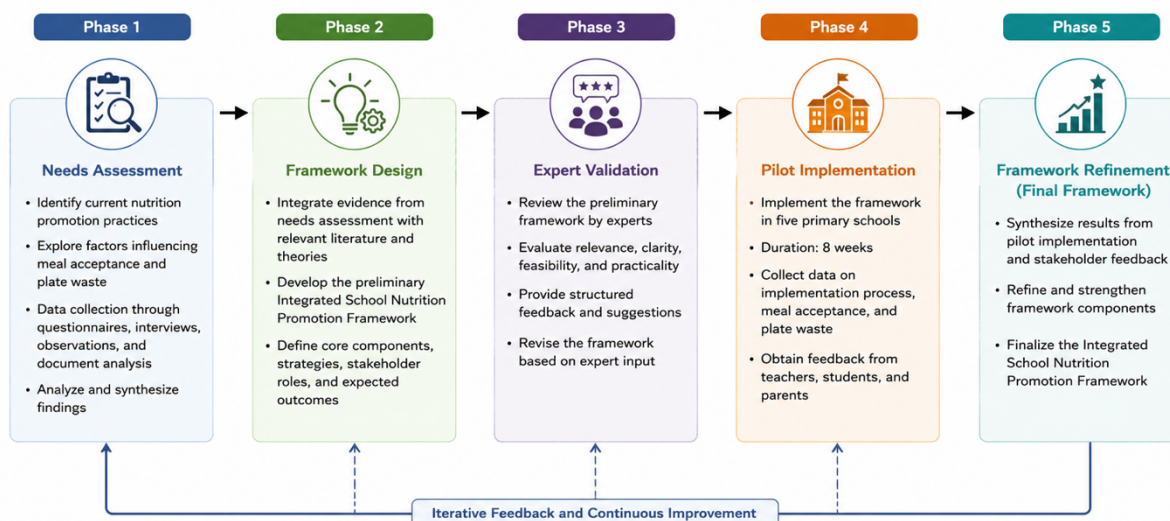


Figure 1. Research Procedure for Developing the Integrated School Nutrition Promotion Framework

The preliminary framework was subsequently subjected to expert validation to evaluate its relevance, feasibility, and practicality. Following revisions, the framework was piloted in five primary schools to examine its applicability within authentic school settings. Finally, findings from the pilot implementation and stakeholder feedback were synthesized to refine the framework, resulting in the final Integrated School Nutrition Promotion Framework.

3.4. Data Collection

Data were collected between January and June 2026 using a combination of quantitative and qualitative methods to obtain comprehensive evidence for framework development. The initial needs assessment was conducted through questionnaires distributed to teachers, parents, school principals, school health coordinators, and nutritionists to identify current nutrition promotion practices, barriers to meal acceptance, and factors contributing to plate waste within the implementation of the Free Nutritious Meal Program. The questionnaire findings were complemented by semi-structured interviews and focus group discussions with selected stakeholders to obtain a deeper understanding of behavioural, educational, social, and environmental factors influencing children's eating behaviours in schools. To strengthen contextual understanding, direct observations were undertaken during school meal activities to document students' meal acceptance, eating behaviours, teacher involvement, peer interactions, and food waste practices.

Furthermore, national policy documents, school nutrition guidelines, and relevant scientific literature were analysed to identify theoretical and practical components that informed the initial framework design. The preliminary framework was subsequently evaluated through two rounds of expert review involving specialists from nutrition, health promotion, public health, primary education, educational psychology, and behavioural science. Feedback obtained from each validation cycle was incorporated into successive revisions before the framework was piloted in participating schools.

3.5. Data Analysis

Quantitative data obtained from the questionnaires were analysed using descriptive statistics to summarize stakeholders' perceptions and identify priority areas for school nutrition promotion. Qualitative data generated from interviews, observations, and document analysis were analysed using thematic analysis following an iterative coding process to identify recurring themes and relationships among behavioural, educational, and environmental determinants of meal acceptance. The findings from both quantitative and qualitative analyses were integrated during the framework development process through methodological triangulation. Expert validation was analysed using the Content Validity Index (CVI) and inter-rater agreement to determine the relevance, clarity, and feasibility of each framework component. Revisions were undertaken after each validation cycle until consensus was achieved regarding the final Integrated School Nutrition Promotion Framework.

3.6. Ethical Considerations

Ethical approval for this study was obtained from the Institutional Research Ethics Committee before data collection commenced. Written informed consent was obtained from all adult participants, while parental consent and child assent were secured for all participating students. All participants were informed that their involvement was voluntary and that the confidentiality and anonymity of their responses would be strictly maintained throughout the research process.

4. RESULT AND DISCUSSION

4.1. Needs Assessment Findings

4.1.1. Nutrition Literacy

Nutrition literacy emerged as a fundamental determinant of students' meal acceptance across the participating schools. As presented in Table 1, stakeholders generally acknowledged the importance of nutrition education in promoting healthy eating behaviours. However, the findings also revealed that nutrition literacy was primarily delivered through occasional health campaigns or science lessons rather than being systematically integrated into everyday classroom practices. Consequently, students possessed basic knowledge about healthy foods but demonstrated limited ability to translate this knowledge into consistent food choices during school meal sessions.

Table 1. Stakeholders' Perceptions of Nutrition Literacy (n = 70)

Indicator	Mean	SD
Students understand the importance of balanced nutrition	4.18	0.62
Nutrition education is integrated into classroom learning	3.41	0.74
Students can distinguish healthy from unhealthy foods	3.95	0.68
Parents reinforce healthy eating habits at home	3.57	0.71
Schools provide sufficient nutrition promotion activities	3.49	0.77

Scale: 1 = Strongly disagree to 5 = Strongly agree.

The interview findings provided further insight into these quantitative results. Teachers consistently reported that nutrition education remained largely knowledge-oriented and was rarely linked to students' actual eating practices during school meals.

One participant explained:

"Students generally know which foods are healthy, but that knowledge does not necessarily influence what they choose to eat during meal times. Many still avoid vegetables or unfamiliar foods despite understanding their nutritional benefits." (Teacher 08)

This finding was corroborated by classroom observations, which showed that several students were able to identify healthy food components but selectively consumed only preferred menu items, leaving vegetables and other nutritious foods unfinished. Such discrepancies suggest that cognitive understanding alone is insufficient to promote desirable eating behaviours without continuous behavioural reinforcement within the school environment.

4.1.2. Teacher Engagement

Teacher engagement emerged as a critical factor in shaping students' eating behaviours during school meal implementation. Beyond delivering nutrition-related content, teachers were expected to act as role models, facilitators, and motivators who continuously reinforce healthy eating behaviours. As shown in Table 2, respondents generally perceived teachers as supportive of nutrition promotion; however, active engagement during meal sessions was less consistently implemented.

Table 2. Stakeholders' Perceptions of Teacher Engagement (n = 70)

Indicator	Mean	SD
Teachers encourage students to consume all meal components	4.27	0.58
Teachers model healthy eating behaviours during school meals	3.56	0.81
Teachers provide nutrition-related guidance during meal sessions	3.68	0.73
Teachers integrate nutrition messages into classroom activities	3.47	0.76
Teachers monitor students' food consumption during school meals	3.74	0.69

Scale: 1 = Strongly disagree to 5 = Strongly agree.

Although the survey indicated a generally positive perception of teacher involvement, interview findings revealed substantial variation in how teachers interpreted and enacted their role. Most participants viewed nutrition promotion as an additional responsibility rather than an integral component of the teaching and learning process. Consequently, teacher involvement often depended on individual initiative rather than a structured school-wide approach.

One teacher stated:

"Our main responsibility is teaching the curriculum. During lunch, we usually remind students to finish their meals, but we rarely have specific strategies or learning activities that encourage healthy eating." (Teacher 05)

School leaders expressed similar views, emphasizing that while teachers were committed to supporting students, they had received limited guidance on implementing nutrition promotion beyond routine supervision.

Classroom observations reinforced these findings. Teachers regularly reminded students to finish their meals and maintain cleanliness; however, opportunities to facilitate discussions about food choices, nutritional value, or healthy eating habits were infrequent. Teacher–student interactions during meal sessions were predominantly supervisory rather than educational, limiting opportunities to strengthen students' nutrition literacy and eating behaviours.

4.1.3. Active Learning

Active learning was identified as an essential pedagogical strategy for strengthening nutrition literacy and promoting positive eating behaviours among primary school students. The needs assessment indicated that nutrition-related learning activities were predominantly delivered through conventional instructional approaches, with limited opportunities for students to actively explore, discuss, or apply nutritional concepts in authentic contexts. As presented in Table 3, respondents perceived that interactive nutrition learning activities were implemented only to a moderate extent across participating schools.

Table 3. Stakeholders' Perceptions of Active Learning in Nutrition Education (n = 70)

Indicator	Mean	SD
Students participate actively in nutrition-related learning activities	3.58	0.72
Learning activities encourage students to discuss healthy food choices	3.64	0.69
Nutrition education involves practical or experiential activities	3.32	0.81
Students are encouraged to reflect on their eating behaviours	3.41	0.77
Classroom activities connect nutrition concepts with daily life	3.55	0.74

Scale: 1 = Strongly disagree to 5 = Strongly agree.

The interview findings highlighted that nutrition education was generally implemented through teacher explanations or textbook-based instruction, with relatively few opportunities for students to engage

in experiential learning. Teachers acknowledged that practical activities, such as food observation, menu evaluation, or group discussions, were effective in stimulating students' interest but were implemented only occasionally due to time constraints and the absence of structured instructional resources.

One participant explained:

"Students become much more enthusiastic when they can directly observe food, discuss the menu, or compare healthy and unhealthy meals. Unfortunately, these activities are not conducted regularly because we do not have a structured learning guide." (Teacher 11)

Observational data further supported these findings. During classroom instruction, students were generally attentive when teachers explained nutrition concepts; however, active participation increased substantially when learning involved interactive tasks, collaborative discussions, or direct engagement with school meals. These activities encouraged students to ask questions, express opinions, and critically evaluate the nutritional quality of foods provided during meal sessions.

4.1.4. Peer Support

Peer support was identified as an important social determinant influencing students' eating behaviours during school meal implementation. The needs assessment indicated that students' willingness to try unfamiliar foods and complete their meals was strongly shaped by peer interactions. As shown in Table 4, respondents generally agreed that classmates played a significant role in encouraging healthy eating behaviours, although structured peer-based nutrition promotion activities were rarely implemented.

Table 4. Stakeholders' Perceptions of Peer Support in School Nutrition Promotion (n = 70)

Indicator	Mean	SD
Students encourage classmates to finish their meals	3.89	0.67
Students are willing to try foods recommended by their peers	3.71	0.73
Positive peer interactions support healthy eating behaviours	3.94	0.65
Schools facilitate peer-based nutrition promotion activities	3.26	0.79
Students learn healthy eating habits through peer interaction	3.82	0.70

Scale: 1 = Strongly disagree to 5 = Strongly agree.

Interview findings revealed that peer influence frequently affected students' food choices during meal sessions. Teachers observed that students were generally more willing to taste unfamiliar foods when encouraged by classmates than when instructed by adults. Positive social interactions often increased students' confidence to try new menu items, whereas negative comments from peers occasionally discouraged food acceptance and contributed to unfinished meals.

One teacher explained:

"When one student says that a particular vegetable tastes good, other children usually become curious and are more willing to try it. On the other hand, if someone complains about the food, many classmates immediately lose interest in eating it." (Teacher 03)

Parents reported similar observations, noting that children often shared their eating experiences with friends and tended to imitate the food preferences of their peer groups. This social influence was particularly evident among younger students, whose food acceptance appeared to be shaped by group dynamics rather than individual preferences alone.

4.1.5. Parental Engagement

Parental engagement emerged as an essential component in reinforcing healthy eating behaviours beyond the school setting. The needs assessment indicated that although parents recognized the importance of balanced nutrition, their involvement in school-based nutrition promotion remained limited. As presented in Table 5, respondents perceived parental support for healthy eating as generally positive; however, communication and collaboration between schools and families regarding nutrition education were less consistently implemented.

Table 5. Stakeholders' Perceptions of Parental Engagement in School Nutrition Promotion (n = 70)

Indicator	Mean	SD
Parents encourage healthy eating habits at home	4.06	0.61
Parents provide balanced meals outside school hours	3.91	0.68
Parents communicate with schools regarding children's eating habits	3.34	0.81
Schools actively involve parents in nutrition promotion programmes	3.29	0.84
Parents reinforce nutrition messages received at school	3.58	0.73

Scale: 1 = Strongly disagree to 5 = Strongly agree.

Interview findings revealed that parents generally supported healthy eating but experienced difficulties maintaining consistent dietary practices at home. Busy work schedules, children's food preferences, and limited knowledge of practical nutrition strategies were frequently identified as barriers to reinforcing healthy eating behaviours. Teachers also noted that the effectiveness of nutrition education at school was often influenced by whether similar practices were maintained within the family environment.

One parent explained:

"At school, children are encouraged to eat vegetables, but at home they often ask for the foods they prefer. Sometimes it is easier to follow their preferences than to insist on healthier options." (Parent 09)

Teachers expressed similar concerns, emphasizing that behavioural changes achieved during school activities were difficult to sustain without parental reinforcement. Classroom observations and discussions with school staff further suggested that communication between schools and families primarily focused on students' academic performance, whereas information regarding eating behaviours, meal acceptance, or nutrition-related concerns was communicated only occasionally. As a result, opportunities to establish consistent healthy eating practices across home and school environments remained limited.

4.1.6. Supportive School Food Environment

The supportive school food environment was identified as the contextual foundation for implementing effective school nutrition promotion. While individual knowledge and behavioural support are important, the needs assessment indicated that these factors were strongly influenced by the broader school environment, including institutional policies, meal management practices, physical facilities, and the overall culture surrounding healthy eating. As presented in Table 6, respondents generally perceived the school environment as supportive; however, several aspects of implementation required further strengthening to optimize meal acceptance and minimize plate waste.

Table 6. Stakeholders' Perceptions of the Supportive School Food Environment (n = 70)

Indicator	Mean	SD
The school promotes healthy eating through school policies	3.88	0.69
Meal schedules are well organized and consistently implemented	4.02	0.61
The dining environment is clean, safe, and comfortable	4.11	0.58
Teachers and school staff consistently support healthy eating practices	3.79	0.66
The school regularly monitors meal acceptance and plate waste	3.18	0.82

Scale: 1 = Strongly disagree to 5 = Strongly agree.

Interview findings indicated that most schools had established routines for meal distribution and supervision; however, systematic nutrition promotion was not yet embedded within school policies or daily management practices. Monitoring activities primarily focused on ensuring that meals were distributed efficiently, while evaluation of students' meal acceptance and plate waste was conducted informally and inconsistently.

One school principal stated:

"Our priority has been ensuring that every student receives their meal on time. However, we have not yet developed a structured system to monitor how much food is actually consumed or why some meals remain unfinished." (Principal 02)

Observational findings supported these perspectives. Meal sessions were generally conducted in orderly and hygienic environments, with teachers supervising students throughout the activity. Nevertheless,

practices related to monitoring food consumption, documenting plate waste, and using these data for continuous programme improvement were rarely observed. Consequently, valuable information that could inform nutrition promotion strategies was often unavailable.

4.2. Development and Validation of the Integrated School Nutrition Promotion Framework

The findings of the needs assessment provided the empirical foundation for developing the Integrated School Nutrition Promotion Framework. Rather than addressing nutrition promotion through isolated interventions, the framework was designed to integrate the six domains identified in the previous section into a coherent and mutually reinforcing system. The framework was further informed by evidence from the literature on school nutrition promotion, nutrition literacy, socioecological theory, behaviour change, and comprehensive school health approaches, ensuring both empirical relevance and theoretical consistency. The preliminary framework was subsequently evaluated through expert review to assess its relevance, clarity, feasibility, and applicability within the context of Indonesian primary schools. Recommendations obtained during the validation process informed several refinements before the framework was finalized.

4.2.1. Expert Validation

Three experts representing the fields of primary education, nutrition, and health promotion independently evaluated the proposed framework using a structured validation instrument comprising four evaluation dimensions: content relevance, conceptual clarity, practical feasibility, and applicability. Content validity was quantified using the Item Content Validity Index (I-CVI) and the Scale Content Validity Index (S-CVI/Ave). The overall validation results indicated excellent content validity across all framework components (S-CVI/Ave = 0.97), demonstrating a high level of agreement among the experts regarding the suitability of the proposed framework. As summarized in Table 7, all six components exceeded the recommended I-CVI threshold of 0.78, indicating that each domain was considered relevant for inclusion in the framework.

Table 7. Expert Validation Results of the Integrated School Nutrition Promotion Framework

Framework Component	I-CVI
Nutrition Literacy	1.00
Teacher Engagement	1.00
Active Learning	0.94
Peer Support	0.94
Parental Engagement	1.00
Supportive School Food Environment	0.94
S-CVI/Ave	0.97

Although the overall evaluation demonstrated excellent validity, experts recommended several refinements to improve the framework's practical implementation. These recommendations primarily

focused on clarifying the relationships among framework components, strengthening parental involvement as a continuous rather than episodic process, explicitly incorporating routine monitoring of meal acceptance and plate waste, and providing clearer implementation guidance for teachers and school leaders. Experts also emphasized that nutrition promotion should be embedded within routine school activities instead of being delivered as stand-alone programmes, thereby enhancing sustainability and institutional ownership.

4.2.2. Final Integrated School Nutrition Promotion Framework

Following expert validation and iterative refinement, the Integrated School Nutrition Promotion Framework was finalized to provide a comprehensive approach for promoting healthy eating behaviours among primary school students. The framework integrates six interdependent components—nutrition literacy, teacher engagement, active learning, peer support, parental engagement, and a supportive school food environment—within a unified school-based nutrition promotion system. The final framework is presented in Figure 3.

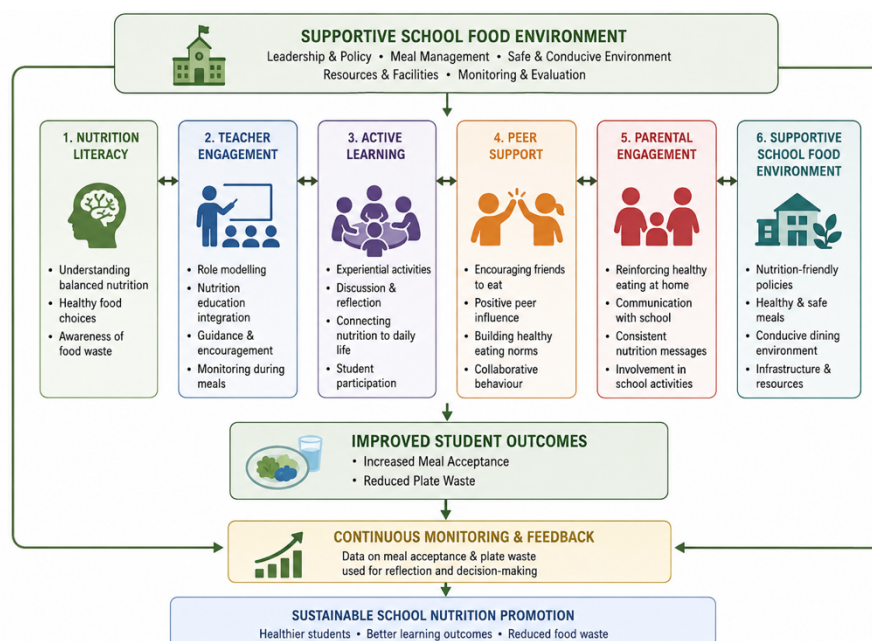


Figure 3. Final Integrated School Nutrition Promotion Framework

Unlike conventional nutrition education programmes that primarily emphasize knowledge acquisition, the proposed framework conceptualizes nutrition promotion as a multidimensional process in which behavioural change is achieved through the interaction of educational, social, familial, and environmental influences. Each component contributes a distinct yet complementary function, creating a reinforcing ecosystem that supports students in developing healthier eating behaviours.

Nutrition literacy serves as the cognitive foundation of the framework by enabling students to understand balanced nutrition, healthy food choices, and the importance of reducing food waste. However, knowledge alone is insufficient to influence behaviour. Teacher engagement and active learning function

as pedagogical drivers that transform nutritional knowledge into meaningful learning experiences through modelling, guided practice, classroom integration, and experiential activities related to school meals.

Behavioural reinforcement is further strengthened through peer support and parental engagement. Positive peer interactions encourage students to try unfamiliar foods, complete their meals, and develop favourable social norms regarding healthy eating. Simultaneously, parental engagement extends nutrition promotion beyond the school setting by reinforcing healthy eating practices at home, thereby creating consistency between home and school environments.

These five components operate within a supportive school food environment that provides the institutional conditions necessary for sustainable implementation. School leadership, nutrition-related policies, meal management procedures, a positive dining environment, and continuous monitoring collectively establish an enabling context in which healthy eating behaviours can be maintained over time.

A distinctive feature of the framework is the integration of continuous monitoring and feedback throughout the implementation process. Information regarding meal acceptance and plate waste is systematically collected and used by teachers and school leaders to evaluate programme effectiveness and identify areas requiring improvement. This feedback mechanism enables schools to refine nutrition promotion strategies based on empirical evidence rather than routine implementation alone, thereby supporting continuous quality improvement.

The interaction among the six components is expected to strengthen students' nutrition literacy, foster positive eating behaviours, increase meal acceptance, and reduce plate waste. Rather than functioning as independent interventions, these components operate synergistically within a whole-school approach, emphasizing that sustainable dietary behaviour change requires coordinated actions involving students, teachers, families, peers, and the broader school environment.

The resulting framework provides an evidence-informed model for implementing school nutrition promotion in Indonesian primary schools. By integrating educational, behavioural, social, and environmental dimensions into a single implementation framework, the model offers practical guidance for schools seeking to improve the effectiveness and sustainability of school meal programmes while simultaneously addressing the challenges of low meal acceptance and high plate waste.

Classroom observations further demonstrated that meal sessions functioned as social learning environments. Students frequently observed one another's eating behaviours, exchanged opinions about menu items, and encouraged friends to finish their meals. However, these naturally occurring interactions were not systematically utilized as part of the school's nutrition promotion strategy.

4.3. Discussion

This study developed and validated an Integrated School Nutrition Promotion Framework to improve meal acceptance and reduce plate waste among primary school students. The framework was empirically grounded in a needs assessment and subsequently refined through expert validation, resulting

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in six interrelated domains: nutrition literacy, teacher engagement, active learning, peer support, parental engagement, and a supportive school food environment. Rather than functioning as independent intervention components, these domains collectively represent a comprehensive school-based ecosystem for promoting healthy eating behaviours.

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One of the principal findings is that nutrition literacy alone is insufficient to change students' eating behaviours. Although teachers and parents generally perceived that students possessed basic knowledge regarding balanced nutrition, this knowledge did not consistently translate into healthier food choices or improved meal acceptance. This finding supports the distinction between knowledge acquisition and behavioural competence proposed by Nutbeam (2000), who argued that health literacy should enable individuals not only to understand health information but also to apply it in everyday decision-making. Similar observations have been reported by Velardo (2015), indicating that nutrition knowledge without supportive behavioural contexts rarely produces sustainable dietary change.

The findings further demonstrate that teacher engagement functions as a critical behavioural catalyst within school nutrition promotion. Teachers influence students not only through formal instruction but also through role modelling, encouragement, and continuous reinforcement during meal sessions. These findings align with the Comprehensive School Health framework, which emphasizes teachers as key agents in creating supportive health-promoting environments (Langford et al., 2015). Likewise, Contento (2016) argued that effective nutrition education requires continuous teacher facilitation that connects classroom learning with students' everyday eating experiences. The present study extends these perspectives by positioning teacher engagement as an integral component of an implementation framework specifically designed to enhance meal acceptance and reduce plate waste.

The importance of active learning identified in this study further reinforces contemporary perspectives on nutrition education. Students demonstrated greater engagement when nutrition concepts were delivered through experiential and participatory activities rather than conventional classroom instruction. Experiential learning encourages learners to construct knowledge through authentic experiences, thereby facilitating deeper conceptual understanding and behavioural application (Kolb, 2015). Similarly, active participation has been shown to improve motivation, knowledge retention, and behavioural outcomes in school health education (Bonwell & Eison, 1991). These findings suggest that nutrition promotion should move beyond information dissemination toward learning experiences that actively involve students in observing, discussing, and reflecting upon their own food choices.

Another significant finding concerns the influence of peer support on students' eating behaviours. The present study found that classmates substantially affected students' willingness to consume unfamiliar foods, supporting social learning theory, which proposes that behaviour develops through observation, modelling, and social interaction (Bandura, 1986). Previous research has similarly demonstrated that positive peer norms contribute to healthier dietary choices and increased acceptance of fruits and vegetables among school-aged children (Salvy et al., 2012). By explicitly incorporating peer support into the

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framework, this study recognizes the social dimension of eating behaviour, which has often received limited attention in school nutrition interventions.

48 The study also highlights the indispensable role of parental engagement in sustaining healthy eating behaviours beyond the school setting. Although parents generally supported balanced nutrition, communication between schools and families regarding children's eating behaviours remained relatively limited. This finding is consistent with Epstein's (2018) theory of school–family partnerships, which emphasizes that meaningful parental involvement enhances children's educational and behavioural outcomes. Similar conclusions have been reported in nutrition research, where parental modelling and home food environments significantly influence children's dietary behaviours (Pearson et al., 2009). Accordingly, strengthening communication and collaboration between schools and families represents a critical strategy for ensuring consistency between nutrition education delivered at school and dietary practices maintained at home.

The sixth domain, supportive school food environment, represents the enabling context within which the other framework components operate. The findings indicate that supportive leadership, institutional policies, meal management practices, and continuous monitoring are necessary to sustain nutrition promotion initiatives. This observation is consistent with the socioecological perspective, which conceptualizes health behaviour as the product of interactions between individuals and multiple environmental systems (Bronfenbrenner, 1979; McLeroy et al., 1988). Likewise, the World Health Organization (2021) emphasizes that effective school health programmes require coordinated institutional support rather than isolated educational activities. The inclusion of continuous monitoring of meal acceptance and plate waste further distinguishes the proposed framework by integrating implementation evaluation into routine school practice.

7 Collectively, the findings suggest that effective school nutrition promotion requires a systems-oriented rather than component-oriented approach. Previous interventions have frequently focused on individual aspects such as nutrition education, school meals, or parental involvement in isolation. In contrast, the present framework integrates cognitive, pedagogical, behavioural, social, familial, and environmental dimensions into a unified implementation model. This integration represents the primary contribution of the study by providing an evidence-informed framework that is both theoretically grounded and practically applicable within Indonesian primary schools.

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14 Several limitations should nevertheless be acknowledged. The framework was developed and validated within primary schools in a single geographical region, which may limit its transferability to other educational contexts. Furthermore, the present study focused primarily on framework development and expert validation rather than large-scale effectiveness testing. Future research should therefore evaluate the framework through longitudinal implementation studies involving diverse school settings and examine its impact on meal acceptance, plate waste, dietary quality, and student health outcomes.

5. CONCLUSION

This study developed and validated an Integrated School Nutrition Promotion Framework to improve meal acceptance and reduce plate waste among primary school students. Grounded in a comprehensive needs assessment and expert validation, the framework integrates six complementary domains (nutrition literacy, teacher engagement, active learning, peer support, parental engagement, and a supportive school food environment) into a unified school-based nutrition promotion system. The findings demonstrate that promoting healthy eating behaviours requires coordinated actions across educational, social, familial, and environmental dimensions rather than isolated nutrition education initiatives.

The primary contribution of this study lies in proposing an evidence-informed implementation framework that bridges the gap between nutrition education and behavioural practice. By incorporating continuous monitoring of meal acceptance and plate waste, the framework provides schools with a practical mechanism for evaluating programme effectiveness and supporting ongoing quality improvement. This systems-oriented approach extends existing school nutrition promotion models by emphasizing the dynamic interactions among multiple stakeholders and institutional contexts.

From a practical perspective, the framework offers guidance for school leaders, teachers, and policymakers in designing comprehensive nutrition promotion programmes that are sustainable and adaptable to primary school settings. Its implementation has the potential to strengthen healthy eating behaviours, improve students' acceptance of school meals, and reduce food waste, thereby contributing to both educational and public health objectives.

Future studies should examine the effectiveness of the proposed framework through large-scale implementation across diverse geographical and socio-cultural contexts. Longitudinal research is also needed to evaluate its impact on meal acceptance, plate waste, dietary quality, nutritional status, and broader student health outcomes, while exploring factors that influence successful implementation in different school environments.

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