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Cultivating Food Literacy for Sustainable Food Security: Local Wisdom-Based Project-Based Learning in Transition to Elementary Education

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Abstract

Food literacy in early childhood is pivotal for establishing healthy eating habits and preparing children to navigate increasingly complex food environments while contributing to sustainable food security. Situated in Indonesia's rich local foodways, this study targets the transition from kindergarten preparation to elementary school as a formative window for culturally grounded learning. This study examined whether a local wisdom-based project-based learning (PjBL) model can strengthen young children's food literacy and early food security during the transition to elementary education. An explanatory sequential mixed-methods design was implemented with 236 children aged 5–6 years in kindergarten preparation classes across five Indonesian cities. Children participated in 10 weeks of local-food PjBL units (gardening, traditional-market visits, simple cooking, and food rituals). Quantitative data from a multi-indicator food literacy and food-security battery were analyzed with partial least squares structural equation modelling, while qualitative data from classroom observations, teacher interviews, and reflective journals were thematically analyzed. The final PLS-SEM model showed that engagement in local-food PjBL predicted higher food literacy ($\beta = 0.573$, $p < .001$, $R^2 = 0.328$) and food security-related behaviors ($\beta = 0.447$, $p < .001$, $R^2 = 0.199$). Qualitative themes of sustained participation, curiosity, collaboration, positive emotions, and authentic pro-sustainability behaviors illustrated how children translated project experiences into everyday food practices at school and home. Overall, the findings indicate that culturally grounded PjBL offers a low-cost, context-sensitive strategy for cultivating food literacy and early food security in elementary education and provide actionable evidence for integrating local-food projects into early-years curricula and policy.

Keywords:

Food Literacy; Food Security; Project-Based Learning; Local Wisdom; Early Childhood Education

Introduction

Addressing food insecurity in Indonesia, particularly among children, requires a multifaceted strategy that integrates agricultural, economic, and educational dimensions. While food insecurity is a global concern, Indonesia presents a critical case where issues of affordability, availability, and sustainability intersect with the educational needs of young children, as underscored by the Global Food Security Index. Climate change further intensifies these pressures by reducing agricultural productivity, raising food prices, and increasing competition for land and water resources (Anjani et al., 2024). These conditions elevate risks for children, who face the dual burden of malnutrition, undernutrition and overnutrition, reflecting broader household food insecurity and highlighting the urgent need for education-led resilience from the earliest years (Firmansyah et al., 2024).

Child undernutrition contributing significantly to disease burdens in low- and middle-income countries (Alaimo et al., 2020). In this context, food literacy emerges as a vital long-term pathway to resilience. Equipping younger generations with the knowledge, skills, and dispositions to make informed food choices fosters healthier dietary behaviours and supports sustainable food security. Experiential learning, such as cooking classes and school gardening, can deepen children's understanding of nutrition and sustainability, promoting lifelong healthy eating habits (Rajat et al., 2024). Aligned with the United Nations' Sustainable Development Goals, especially SDG 2 (Zero Hunger) and SDG 4 (Quality Education), integrating food security education into school curricula is essential to prepare children to navigate and mitigate the impacts of food insecurity.

Despite this urgency, food literacy has not been systematically embedded in Indonesia's early childhood education curriculum. Current approaches to nutrition education remain fragmented, often limited to parental guidance or sporadic health campaigns. Without structured, context-sensitive interventions, children may develop poor dietary habits that persist into later childhood, worsening food insecurity at both household and national levels. International evidence supports the effectiveness of school-based food and nutrition education. Mogre et al., (2024), reporting increased nutrition knowledge and fruit intake among Ghanaian primary school children, showed that parental food education shapes children's food literacy through motivation and family dynamics, and Ülker et al., (2024) found that sustainable food literacy programs improve attitudes and behaviours in primary grades. Together, these studies highlight a research-to-practice gap in Indonesia, despite a robust evidence base, local implementation remains limited.

The transition to elementary education (kindergarten preparation class, ages 5–6) represents a pivotal developmental window when children's food attitudes, preferences, and behaviors take shape. At this age, learners are particularly receptive to experiential pedagogy and cultural values, making it an ideal period for instilling sustainable eating habits. Longitudinal research indicates that dietary patterns established in early childhood strongly predict later health outcomes. Ares et al., (2024) further emphasize that childhood food literacy competencies underpin the ability to navigate complex food environments throughout life. Strengthening food literacy during this preschool-to-elementary transition is thus not only essential for child health but also a strategic lever for addressing national food insecurity.

Indonesia possesses rich cultural assets, home gardening, traditional markets, community food rituals, and regional culinary heritage, that offer valuable educational resources. Embedding such local wisdom into food literacy curricula can strengthen children's cultural identity while linking learning to sustainable food systems. Simultaneously, Project-Based Learning (PjBL) is a proven approach for fostering engagement, critical thinking, and problem-solving. Yet, the integration of PjBL with local wisdom in early childhood food literacy remains underexplored in Indonesia. International research, such as that by Zaki et al., (2024) suggests that combining local culture with experiential learning reinforces cultural sustainability and 21st-century skills, though rigorous empirical studies are still lacking on how this model can be systematically applied during the transition to elementary school while addressing broader food insecurity.

This study evaluates the effectiveness of a local wisdom-based PjBL approach in cultivating food literacy among kindergarten preparation students transitioning to elementary education. It contributes in three key ways: first, by bridging early childhood and elementary education through an intervention situated at a critical developmental stage; second, by aligning food literacy education with sustainable food security goals in response to challenges highlighted by Indonesia's food insecurity context; and third, by employing a mixed-methods design that integrates quantitative evidence from child participants with qualitative insights from teachers and classroom processes to generate actionable implications for curriculum and policy. Situated at the intersection of cultural and pedagogical innovation, this research aims not only to extend current scholarship on early food literacy, but also to provide a clearer understanding of how and under what conditions culturally grounded project-based learning supports children's food-related development. To make the analytical direction of the study more explicit and to align the quantitative and qualitative strands, the

following research questions guided the inquiry, (1) To what extent does children's engagement in local-wisdom–based Project-Based Learning (PjBL) predict food literacy during the transition to elementary education? (2) To what extent does children's engagement in local-wisdom–based PjBL predict early food-security–related behaviors? (3) How do classroom observations, teacher interviews, and reflective journals explain the mechanisms through which local-wisdom–based PjBL shapes children's food literacy and food-security–related outcomes across diverse Indonesian contexts?

Theoretical Perspective

This study is grounded in a multi-layered theoretical stance that explains how a local-wisdom–based Project-Based Learning (PjBL) approach can cultivate food literacy in children at the transition to elementary education and, in turn, contribute to sustainable food security. We conceptualize learning as a culturally situated, experientially mediated process that is shaped by individual motivation and agency, nested family–school–community influences, and broader sociocultural and ecological contexts. The perspective integrates (a) constructivist and experiential learning foundations of PjBL, (b) culturally relevant and place-based pedagogy, (c) the food-literacy framework for early/elementary years, (d) motivation and self-efficacy mechanisms, (e) a socio-ecological lens on multi-level influences, and (f) evidence that habits established in the kindergarten preparation year track into early grades.

PjBL as experiential, constructivist learning

Project-Based Learning (PjBL) in food and nutrition education offers a constructivist, experiential pathway in which children learn through meaningful projects—school gardening, simple cooking, and community food rituals, via cycles of concrete experience, reflection, conceptualization, and experimentation (Salimon, 2022). Evidence from school-based culinary programs indicates that combining tasting, gardening, and cooking can improve attitudes toward vegetables and fruits and yield modest gains in intake (Bennett et al., 2021). Classroom implementations also cultivate transversal skills, autonomy, reflective thinking, and collaborative work, linking curricular aims to children's lived food ecologies and elevating engagement and motivation (Franco-Dall'Agnol et al., 2021; Torres et al., 2018). To maximize impact across diverse contexts, initiatives should anticipate constraints in resources and teacher preparedness, pair projects with professional learning and community partnerships, and pursue rigorous longitudinal evaluation while preserving the approach's experiential and contextual integrity.

Culturally relevant and place-based learning

Integrating local wisdom into Project-Based Learning (PjBL) heightens cultural relevance and educational sustainability, especially within Indonesian foodways where home gardens, traditional markets, communal cooking, and food rituals offer authentic contexts for inquiry. When projects are anchored in these lived practices, children see their family traditions and community knowledge reflected in classroom tasks, strengthening identity and a sense of belonging while transforming abstract concepts about nutrition, sourcing, and waste into concrete, meaningful action. This culturally grounded PjBL also advances 21st-century competencies, critical thinking, collaboration, problem solving, and cultural sustainability, as learners investigate where food comes from, compare purchasing choices, and design simple strategies to reduce waste, thereby linking everyday decisions to broader ecological and community well-being. Empirical work on environment-based learning that incorporates local wisdom supports these claims, reporting gains in higher-order thinking and pro-environmental attitudes among students (Hadi et al., 2022). In short, local-wisdom PjBL does not merely teach about food; it invites children to learn with and through their cultural food ecologies, cultivating knowledge, dispositions, and skills that travel with them beyond the classroom.

Food literacy for the early/elementary years

Food literacy in young children is foundational to cultivating healthy eating habits and equipping them to navigate increasingly complex food environments. A tripartite perspective, encompassing functional, interactive, and critical competencies, maps well onto the formative kindergarten-preparation stage, a period marked by high plasticity and curiosity that is ideal for embedding core knowledge, skills, and dispositions related to food. Functionally, early programs introduce foundational concepts such as food groups, hygiene, and the origins of food to support informed dietary choices (Ares et al., 2024) and extend to practical basics like reading food labels and simple cooking tasks that deepen children's understanding of nutrition (Omidvar et al., 2023). Interactive competencies are fostered through hands-on preparation and tasting activities that help children express preferences, exercise choice, and build confidence in everyday food decisions (Kelly & Nash, 2021), when these experiences incorporate diverse culinary practices, they also nurture cultural awareness and inclusivity by validating multiple food identities and traditions. Critical competencies, in turn, engage values and reasoning about health, environmental impacts, and fairness across food systems, while developing media literacy to recognize and resist persuasive food marketing (Elliott et al.,

2022). Although the evidence base for early food literacy is promising, many interventions still cluster around functional skills with comparatively limited attention to critical dimensions, indicating the need for more balanced designs that integrate functional, interactive, and critical learning aims across curricula and family–school contexts (Kelly & Nash, 2021).

A socio-ecological lens on supports and constraints

Children's food behaviors reflect nested systems (Bronfenbrenner, 1979), including individual knowledge and preferences; microsystems (e.g., family food rules, teacher practices); mesosystem linkages (e.g., school–home projects, community partners); and exosystem/macro layers such as local markets, cultural norms, and policy (Purkait, 2024; Suwannawong et al., 2023). A socio-ecological stance clarifies why classroom projects alone may be insufficient unless they are networked with families and community food assets (e.g., field visits to traditional markets, school–home recipe journals) since interventions grounded only at the school level often have limited sustained impact without support from home and local environments (Davis et al., 2021; Purkait, 2024). This perspective also illuminates moderators that condition impact: teacher capacity and implementation fidelity, parental engagement, socioeconomic constraints, and urban–rural access to local produce (Randby et al., 2024; Swindle et al., 2022).

Habit formation and tracking across the transition

The kindergarten-preparation year is not merely preparatory; it is formative. Patterns of preference, willingness to taste, mealtime routines, and basic hygiene consolidate and subsequently track into the first years of elementary school. Longitudinal and prospective findings indicate that early dietary patterns predict later diet quality; furthermore, early food-literacy competencies scaffold later self-regulation in complex food environments (Appannah et al., 2024; Ares et al., 2024; Russell & Russell, 2025). Thus, intervening before entry to elementary is strategically efficient for shaping sustainable behaviors and for buffering against the dual burden of malnutrition in contexts of food insecurity (Appannah et al., 2024; Gispert-Llauradó et al., 2025).

Theory of change and propositions

Bringing these strands together, the intervention inputs—local-wisdom–based project-based learning (PjBL) units, such as gardening modules, market explorations, simple cooking activities, and food-related storytelling—activate proximal mechanisms including experiential engagement, culturally anchored meaning-making, self-efficacy, and autonomous motivation (Corbacho-Cuello & Muñoz-Losa, 2025; Sharp et al., 2025; Van Der Horst et al., 2024). These mechanisms yield proximal outcomes by the end of the transition year, such as improvements in functional food knowledge, more positive attitudes and perceived norms toward healthy and sustainable food, and basic interactive skills like choosing, simple food preparation, and tasting. As children transition into elementary school, these early competencies are expected to scaffold distal outcomes, including increased acceptance of vegetables and fruit, more consistent breakfast and hygiene routines, reduced plate waste, and the emergence of early sustainability reasoning (Gispert-Llauradó et al., 2025; Marquis et al., 2023). The effects are likely to be stronger in contexts with supportive moderators such as high teacher fidelity, active parental involvement, and access to local produce, and weaker where structural constraints are acute. Nonetheless, even modest classroom-level shifts can catalyze longer-term gains when mesosystem linkages—such as school–family–community connections—are deliberately cultivated (Sharp et al., 2025).

Methodology

We employed an explanatory sequential mixed-methods design (QUAN→QUAL) with a classroom-based quasi-experimental pre–post evaluation. The quantitative phase estimated change in children's food literacy before and after a local-wisdom Project-Based Learning (PjBL) intervention. The subsequent qualitative phase, structured classroom observations, semi-structured teacher interviews, and reflective journals, functioned as a qualitative experiment embedded in a pedagogical intervention, used to interpret the size and nature of observed effects, illuminate mechanisms (engagement, meaning-making, self-efficacy), and surface implementation facilitators/barriers. This pairing of experimental manipulation with qualitative inquiry follows the pedagogical/qualitative-experiment tradition in education research, where experimental procedures are complemented by qualitative analyses to explain outcomes and contextualize effectiveness (Krasovska et al., 2020).

Setting and participants

The study was conducted in kindergarten preparation classes (ages approximately 5–6 years) located in five Indonesian cities across five different provinces, representing diverse sociocultural and food environments: Denpasar (Bali), Bandung (West Java), Yogyakarta (Special Region of Yogyakarta), Jambi (Jambi Province), and Pontianak (West Kalimantan). In total, 236 children (Denpasar n = 32; Bandung n = 62; Yogyakarta n = 50; Jambi n = 40; Pontianak n = 52) constituted the primary analytic sample. In each site, early childhood teachers who were directly responsible for the preparation classes were involved as co-implementers of the intervention and as key

informants for the qualitative strand, yielding 24 teachers overall (5 in Denpasar, 6 in Bandung, 4 in Yogyakarta, 5 in Jambi, and 4 in Pontianak).

Participating schools were treated as distinct clusters, and grouping at the school/class level was maintained to minimize cross-group contamination of the intervention. Inclusion criteria for children were: (a) enrolment in a kindergarten preparation class, (b) at least 80% attendance during the intervention period, and (c) written parental consent. Teachers were eligible if they held primary pedagogical responsibility for the class, had been teaching at the school for at least one academic year, and agreed to participate in observation, reflection, and interview activities associated with the study.

The sample size was considered adequate for the specified PLS-SEM model, given the study's predictive objective and relatively limited number of latent constructs and structural paths. Consistent with current methodological guidance, adequacy was considered in relation to model complexity and statistical power rather than absolute participant counts alone (Hair & Alamer, 2022). The inclusion of five school clusters from geographically and culturally distinct Indonesian provinces was intended to capture meaningful variation in local foodways and implementation contexts rather than to achieve national representativeness. This multisite strategy strengthened the contextual relevance of the intervention and supported the transferability of the findings across diverse classroom settings by allowing the study to account for contextual complexity and cross-site variation (Czosnek et al., 2022; Mielke et al., 2022).

Measures

Children's food literacy was assessed with a multi-method battery covering functional, interactive, and critical competencies, consistent with contemporary frameworks for food literacy in childhood (Ares et al., 2024). All tools were adapted to early-years settings using pictorial supports, play-based tasks, and teacher-facilitated administration to ensure developmental appropriateness, and were implemented within local-wisdom PjBL units (gardening, traditional-market visits, simple cooking/tasting, food rituals) supported by evidence on experiential, culturally grounded food education (Hu & Ødemotland, 2021; Mogre et al., 2024; Moore Heslin et al., 2024; Zaki et al., 2024).

Table 1

Food Literacy and Project-Based Learning

Instrument	Construct & Domains	Example indicators / sample item	Response & scoring	Administration
Child Food Literacy Composite (pictorial quiz + play-based tasks; ~10 items)	Functional–Interactive–Critical (early-years lens)	Differentiate local fruits vs. vegetables; group foods by origin (garden/field/sea); identify healthy vs. less healthy options; justify a healthy lunch; propose a simple local menu; willingness-to-taste; hand-washing routine; invite peers to try new food; use new food vocabulary; avoid plate waste	Pictorial choices / oral prompts scored 0–1 or rubric 1–4; composite standardized to 0–100	Pre–post (Week 0 & 11); small-group, teacher-facilitated
Participatory Classroom Observation (PjBL)	Engagement, initiative/curiosity, collaboration, emotion; food-security behaviors	Active in planting/cooking/discussion; asks questions; shares tools; shows positive affect; explains "farm-to-plate"; practices not wasting food; cares for plants; uses garden tools safely; willingness to share harvest	Observer rubric 1–4 per indicator; session notes	Each PjBL session (Weeks 1–10)
Teacher Observation—HOTS ladder (10 prompts)	HOTS-aligned indicators (C2–C6) in food contexts	C2: pick the healthy drink; C3: demonstrate handwashing; C4: distinguish local vs. instant food; C5: give a reason not to waste food; C6: design a simple lunch box	Correct/incorrect and/or rubric 1–4 with anecdotal note	Integrated in lessons; pre–post comparable prompts
Child Interview (stimulus-based)	Lived experiences & meanings	"Which local food do you like and why?"; "What did you plant at school?"; "What would you do with leftovers?"	Short narrative; thematic coding (no score)	Post-intervention sub-sample; 1:1 or dyads
Teacher Semi-structured Interview	Implementation, perceived change, barriers/enablers, cultural reinforcement	"What child changes did you notice?"; "How did local practices strengthen learning?"	Narrative; thematic coding	Post-intervention; ~30–45 min/site
Teacher Daily Reflective Journal	Process tracing & fidelity	What worked; child responses; challenges; next-step ideas	Narrative; process codes; fidelity checklist	Each session/week during PjBL

Notes on scale anchors and scoring. Observation rubrics use a 4-point scale (1 = not yet; 4 = consistent/independent). Pictorial quiz items score 0/1 or 1–4 as specified; all item scores are rescaled to a composite 0–100 to aid interpretability across sites.

Procedures

The intervention consisted of a sequence of project-based learning (PjBL) units designed to connect children's everyday food ecologies with structured classroom learning. Across sites, units typically involved school or home gardening activities (e.g., planting and caring for leafy vegetables), visits to traditional markets, simple cooking and tasting sessions using locally available ingredients, and engagement with community food rituals. Each PjBL unit followed a common pedagogical cycle—inquiry → planning → doing → reflection → sharing—in which children were encouraged to pose questions, co-plan activities with the teacher, participate in hands-on tasks, and then reflect on and communicate what they had learned. To support consistency of implementation across provinces, teachers received concise orientation materials for each unit, including learning goals linked to the study constructs (engagement, food literacy, food security), step-by-step activity guides, structured observation sheets, and authentic-assessment rubrics.

Data collection proceeded in three main waves. At pre-test (Week 0), children completed baseline assessments of engagement-related behaviors, food literacy, and food-security–related attitudes and practices. Between Weeks 1 and 10, teachers implemented multiple PjBL units while simultaneously documenting process indicators (e.g., children's participation, questions, collaborative interactions, and emotional responses) through field notes and checklists. At post-test (Week 11), the same core measures were re-administered to capture change over time. The qualitative phase followed in Weeks 12–14, combining focused classroom observations, semi-structured interviews with participating teachers (approximately 30–45 minutes per site), and one-week reflective journals in which teachers described salient episodes, perceived mechanisms of change, and contextual enablers or barriers. These qualitative data were used to elaborate how and under what conditions the PjBL units influenced children's engagement, food literacy, and early food security.

Data analysis

Quantitative data were analyzed using partial least squares structural equation modeling (PLS-SEM). The analyses were conducted in two main stages. First, we assessed the measurement (outer) model by examining individual item loadings, internal consistency reliability (Cronbach's alpha and composite reliability), convergent validity (average variance extracted, AVE), and discriminant validity using the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio. Items with very low standardized loadings were removed iteratively while retaining sufficient indicators to represent each latent construct. Second, we evaluated the structural (inner) model by estimating the path coefficients from engagement to food literacy and food security, together with their t-values and p-values based on bootstrapping with 5,000 resamples. We also inspected the explained variance (R^2), predictive relevance (Q^2), and global goodness-of-fit indices to judge overall model adequacy.

Qualitative data (classroom observations and teachers' reflective journals) were analyzed thematically following an iterative, primarily inductive approach. Initial open coding focused on segments of text that described children's participation, questions, interactions, emotional expressions, and food-related talk during project sessions. Codes were then clustered into higher-order categories and themes that captured recurring patterns across cases. To enhance trustworthiness, two researchers independently coded a subset of the data and resolved discrepancies through discussion; an audit trail of coding decisions was maintained, and emerging interpretations were checked against the raw data.

Integration of quantitative and qualitative findings followed a convergent mixed-methods logic. After analyzing each strand separately, we created joint displays that aligned latent constructs and indicators from the PLS-SEM model with qualitative themes and illustrative excerpts. These joint displays were then used to derive meta-inferences about how engagement in local-wisdom–based project work contributed to children's food literacy and food security outcomes.

Quality assurance and bias mitigation

Several strategies were employed to enhance implementation quality and minimize potential sources of bias. Prior to the intervention, participating teachers received concise, practice-oriented guidance and coaching on how to deliver the BIMA local-food PjBL activities and how to document children's engagement and responses in a consistent manner. Throughout data collection, post-test assessors were kept blind to children's baseline scores and classroom allocation to reduce expectancy effects. Implementation fidelity was monitored periodically using simple checklists and field notes that captured adherence to core project components, dosage, and deviations from the protocol. Where appropriate, statistical analyses took into account the clustered nature of the data at the classroom/school level so that standard errors and significance tests were not biased by within-class dependence.

Ethical considerations

The study received formal ethical clearance from the relevant institutional review board, and all procedures were carried out in accordance with national guidelines for research with young children. Written informed consent was obtained from parents or legal

guardians prior to participation, and age-appropriate assent was sought from the children using simple explanations about the activities and their voluntary nature. All personal identifiers were removed from datasets and replaced with anonymized codes; any visual documentation (e.g., photographs or short video clips) strictly complied with school policies and parental permissions. Cooking and tasting activities were conducted under close adult supervision, following basic hygiene standards and allergy-aware procedures, including consultation with parents and schools regarding dietary restrictions and health conditions.

Results

This section presents the findings from both strands of the study. We first report the quantitative results of the PLS-SEM analyses, examining how children's engagement in the local-food project predicts their food literacy and food-security–related outcomes. We then describe the qualitative findings from classroom observations, teacher interviews, and reflective journals, which provide a more nuanced picture of how the intervention played out in practice. Finally, we offer an integrated interpretation of the quantitative and qualitative evidence, highlighting points of convergence, complementarity, and tensions to illuminate the mechanisms through which the learning model supports children's learning during the transition to elementary school.

Quantitative Results

Measurement Model

In the initial measurement model, the indicator ENG2 (initiative/curiosity) showed a very low and non-significant loading on the latent construct (λ = 0.124; and −0.047 in the full model), far below the recommended 0.50 threshold. This suggested that initiative/curiosity, as operationalized in this item, did not converge adequately with the other engagement indicators. Therefore, ENG2 was removed during model reduction to improve convergent validity, composite reliability, and AVE for the Engagement construct.

The reduced PLS-SEM model retained 3 indicators for Engagement (ENG1, ENG3, ENG4), 3 indicators for Food Literacy (FL1–FL3), and 8 indicators for Food Security (FS1, FS2, FS4, FS6–FS10). All retained items exhibited standardized loadings ≥ .50, indicating adequate item reliability. In the final model, engagement indicators loaded strongly on their latent construct (0.813–0.855), while food literacy indicators ranged from 0.595 to 0.911 and food-security indicators from 0.506 to 0.903. These results are summarized in Table 2.

The measurement model demonstrated satisfactory item performance and construct reliability. For engagement, the indicators (ENG1–ENG4) showed strong standardized loadings on the latent construct (0.813–0.855), indicating that active participation, social collaboration, and affective involvement are all robust manifestations of children's engagement in the local-food PjBL activities. The composite reliability for engagement was high (CR = 0.876), and the AVE exceeded the recommended 0.50 threshold (AVE = 0.701), suggesting good internal consistency and indicating that more than 70% of the variance in the indicators is explained by the underlying construct.

For food literacy, the two core indicators (FL1 and FL2) exhibited very high loadings (0.899 and 0.911), while FL3 showed a more moderate loading (0.595) but remained above the minimum acceptable value of 0.50. Together, these indicators yielded a composite reliability of 0.852 and an AVE of 0.664, indicating that the construct is measured reliably and that a substantial proportion of the variance in its items is attributable to the latent factor rather than to measurement error.

Table 2.
Measurement model, standardized factor loadings, composite reliability, and AVE

Construct	Indicator	Standardized loading	Composite reliability	AVE
Engagement	ENG1	0.855	0.876	0.701
	ENG3	0.813	–	–
	ENG4	0.844	–	–
Food literacy	FL1	0.899	0.852	0.664
	FL2	0.911	–	–
	FL3	0.595	–	–
Food security	FS1	0.838	0.887	0.504
	FS2	0.903	–	–
	FS4	0.574	–	–
	FS6	0.506	–	–
	FS7	0.640	–	–
	FS8	0.707	–	–
	FS9	0.610	–	–
	FS10	0.802	–	–

The food security construct was represented by eight indicators, with loadings ranging from 0.506 to 0.903. The highest loading (FS2 = 0.903) suggests that this indicator is a very strong reflector of the underlying food security construct, whereas FS4 and FS6, with loadings just above 0.50, can be considered acceptable, albeit somewhat weaker, indicators. Overall, the composite reliability for food security was good (CR = 0.887), and the AVE met the conventional 0.50 cut-off (AVE = 0.504), implying that the construct has adequate convergent validity despite the inclusion of a few moderately loading items. Taken together, the pattern of factor loadings, composite reliability, and AVE values supports the conclusion that the three latent variables, engagement, food literacy, and food security, are measured with acceptable reliability and convergent validity in this sample.

Composite reliabilities for the three constructs were high: CR = 0.876 (Engagement), 0.852 (Food Literacy), and 0.887 (Food Security), exceeding the recommended threshold of 0.70 and indicating good internal consistency. Average variance extracted (AVE) values were 0.701, 0.664, and 0.504, respectively, surpassing the 0.50 criterion for convergent validity.

Discriminant validity was supported at both the indicator and construct levels. Cross-loadings showed that each indicator loaded more strongly on its own construct than on other constructs. The Fornell–Larcker criterion was also met: the square roots of the AVE for Engagement (0.838), Food Literacy (0.815), and Food Security (0.710) were greater than their inter-construct correlations (ranging from 0.447 to 0.710), as shown in Table 3.

Table 3.
Discriminant validity (Fornell–Larcker criterion)

Construct	Engagement	Food literacy	Food security
Engagement	0.838	0.573	0.447
Food literacy	0.573	0.815	0.710
Food security	0.447	0.710	0.710

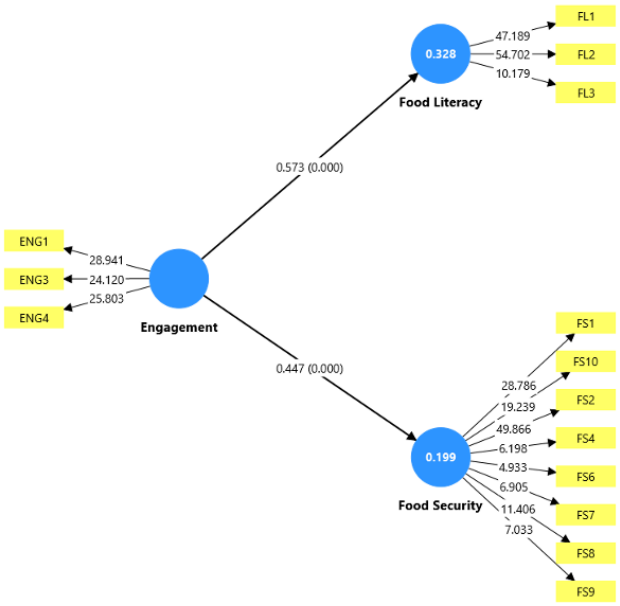
The square roots of AVE for engagement (0.838), food literacy (0.815), and food security (0.710) are greater than or equal to their correlations with the other constructs (off-diagonal values). This pattern indicates that each construct shares more variance with its own indicators than with other latent variables, thereby supporting discriminant validity. At the same time, the relatively high correlation between food literacy and food security (r = 0.710) suggests that, while empirically distinguishable, these two constructs are conceptually related, consistent with the theoretical expectation that children who are more food literate also tend to exhibit more secure and sustainability-oriented food practices.

Finally, HTMT ratios were below the conservative cut-off of 0.90 (Engagement–Food Literacy = 0.676; Engagement–Food Security = 0.303; Food Literacy–Food Security = 0.697), further indicating that the three constructs captured distinct but related dimensions of children's learning and behaviors. Overall, the measurement model demonstrated acceptable reliability, convergent validity, and discriminant validity, supporting the use of these latent constructs in subsequent structural analyses.

Structural model: Engagement Predicting Food Literacy and Food Security

Figure 1 presents the final PLS-SEM structural model. Engagement is specified as an exogenous construct predicting two endogenous constructs, Food Literacy and Food Security, and is reflected by three indicators (ENG1, ENG3, ENG4), whereas Food Literacy and Food Security are reflected by FL1–FL3 and FS1, FS2, FS4, FS6–FS10, respectively. The model showed moderate explanatory power, accounting for 32.8% of the variance in Food Literacy and 19.9% of the variance in Food Security.

Figure 1
Final PLS-SEM model



Children's engagement in local-food PjBL was positively and significantly associated with both outcomes: Engagement → Food Literacy: β = 0.573, p < .001; and Engagement → Food Security: β = 0.447, p < .001. These coefficients indicate that higher levels of behavioral, social, and emotional engagement in the PjBL activities were associated with higher food literacy scores and more positive food-security–related behaviors. As shown in Table 4, both paths were statistically significant with relatively large t-values, and the R^2 values indicate moderate (Food Literacy) and weak-to-moderate (Food Security) explanatory power.

Inspection of collinearity statistics showed no evidence of problematic multicollinearity (all VIF values < 5), and predictive relevance indices (Q^2) indicated that the model possessed satisfactory out-of-sample predictive capability for both endogenous constructs. Taken together, the structural model supports the hypothesized role of engagement as a central mechanism through which the local-wisdom PjBL intervention influences children's food literacy and early food-security–related outcomes.

By combining a multi-site quasi-experimental design with PjBL units grounded in local food wisdom and a mixed-methods analytic strategy, this study captured both the measurable and lived dimensions of children's engagement, food literacy, and early food security. The PLS-SEM approach confirmed that the measurement model for the three latent constructs was psychometrically sound, and the structural model supported the theorized role of engagement as a central mechanism in the intervention. Quantitatively, children who were more actively, socially, and affectively engaged in the Learning Model project showed significantly higher levels of food literacy and food security–related outcomes, with engagement explaining a meaningful proportion of the variance in both constructs. These results indicate that the methodological choice, clusters of preparation classes across provinces, a standardized PjBL cycle, and rigorous modelling of latent variables—was appropriate for testing the theory of change and provides robust evidence that culturally grounded, hands-on learning can promote both food-related knowledge and more sustainable food practices in the transition-to-elementary context.

Qualitative Results

To provide an overview of the qualitative strand, Table 5 summarizes the five themes that emerged from the analysis of classroom observations, teacher reflective journals, and interview excerpts. Each theme captures a distinct yet interconnected facet of children's participation in the local-wisdom PjBL activities—ranging from behavioral engagement in gardening and cooking projects, through initiative, curiosity, collaboration, and emotional–expressive responses, to authentic behaviors and meaning making related to sustainability and family food practices. The table also highlights how each theme links theoretically to the outcome constructs of classroom engagement, food literacy, and food security, illustrating how children's lived experiences in the project served as a pathway for developing knowledge, skills, values, and dispositions around food and everyday food practices.

Table 4.

Structural model results: path coefficients, significance, and explained variance

Endogenous construct	Predictor	Path coefficient (β)	Standard error (SE)	t-value	p-value	R^2 of endogenous construct
Food Literacy	Engagement	0.573	0.047	12.291	< .001	0.328
Food Security	Engagement	0.447	0.041	10.908	< .001	0.199

Note. Path coefficients, standard errors, and test statistics are based on PLS-SEM with 5,000 bootstrap resamples. Both paths from Engagement to Food Literacy and Food Security are positive and statistically significant ($p < .001$). The model explains 32.8% of the variance in Food Literacy and 19.9% of the variance in Food Security, indicating moderate and weak-to-moderate explanatory power, respectively.

Table 5.

Summary of Qualitative Findings

No.	Theme	Description	Link to outcome constructs
1	Children's engagement in project activities	Children participated actively in all stages of gardening and cooking projects, taking roles that matched their interests and sustaining attention throughout the sessions.	Core behavioral expression of classroom engagement; provides the experiential basis for developing food literacy and food security.
2	Initiative and curiosity	Children showed high levels of initiative and curiosity about plants, ingredients, and cooking processes, often initiating questions and explorations without teacher prompts.	Cognitive–affective dimension of engagement; supports the development of conceptual food literacy (knowledge, understanding of processes).
3	Collaboration and social cooperation	Project activities prompted frequent collaboration, with children sharing tools, dividing tasks, and helping peers during gardening and cooking.	Social dimension of engagement; builds socio-emotional skills that underpin collective food practices and communal aspects of food security.
4	Emotions and expressive responses	Children experienced predominantly positive emotions and used expressive language to share their feelings about project activities and foods.	Affective component of engagement; positive emotions and emerging emotion regulation support sustained participation and openness to learning about food.
5	Authentic behaviors and meaning making	Children translated project experiences into authentic behaviors and meanings related to sustainability, sharing, and family food practices.	Embeds food literacy and food security in children's values and everyday practices (e.g., anti-food-waste attitudes, simple economic understanding, family and cultural identity).

Building on this summary, the following subsections elaborate each theme in greater depth. For each theme, we describe how it was manifested across different classrooms and illustrate the pattern with selected excerpts from teacher reflections and classroom interactions. These narrative accounts provide contextual detail on how children engaged in gardening and cooking projects, how they showed initiative and curiosity, collaborated with peers, expressed emotions, and translated project experiences into authentic behaviors and meanings around food and sustainability.

In the quotations that follow, the code T refers to teachers (e.g., Teacher T1, T3, T7), while S refers to children or students (e.g., S1, S2). This notation preserves participants' anonymity while allowing readers to trace how individual voices exemplify each theme. Together, the thematic descriptions and illustrative quotes enrich the summary presented in Table 5 by showing how the qualitative findings concretely link to the outcome constructs of classroom engagement, food literacy, and food security.

Theme 1: Children's Engagement in Project Activities

Across sites, children displayed consistently high engagement in gardening, cooking, tasting, and discussion activities. Teachers reported strong behavioral engagement, with most children eagerly participating in tasks such as watering, planting seeds, washing vegetables, and stirring batter.

> *One teacher noted, "Most of the children were very enthusiastic. During the kangkung planting session, they were happy to water the soil, sprinkle the seeds, and cover them with soil. In the simple cooking activity, some children helped wash vegetables and stir the batter with great excitement" (T1).*

> *Another teacher described how "the children enthusiastically followed the planting process from beginning to end with joy" and took on different roles such as mixing soil and compost, placing seeds into small holes, or carefully holding the watering can (T3–T4).*

Engagement was also reflected in cognitive involvement. During discussions, children named local traditional foods, linked them to family experiences, and articulated simple reasons for why certain foods were "healthy" or "good for energy".

> *For example, one teacher observed that while practicing planting, "S1 and S2 eagerly scooped soil into the polybag, Aprilia was very enthusiastic about watering, while S3 prepared the container. In the discussion, S4 mentioned his Favorite traditional food, S5 and S6 added that he had seen this food at home" (T9).*

> *Another reflection highlighted that children could name traditional foods they recognized when discussing healthy food, demonstrating that their engagement extended beyond physical participation to conceptual understanding and reflective talk (T1).*

> *Children's engagement also involved initiative and preparation for project activities. One teacher reported that children willingly brought recycled cups, manure, and other tools from home, queued patiently to take turns planting, and chatted with peers about whether their plants would grow and be harvested later, showing both excitement and sustained focus on the project goals (Teacher T7).*

Overall, these accounts illustrate how PjBL created rich opportunities for behavioral, cognitive, and social engagement in food-related learning.

Taken together, these observations illustrate the core behavioral expression of classroom engagement and provide the experiential foundation on which children's food literacy and early food-security–related behaviors can develop.

Theme 2: Initiative and Curiosity

Children frequently initiated questions about plants, ingredients, and cooking processes, demonstrating strong initiative and curiosity. They asked what seeds were being planted, why fertilizer was used, how long plants would grow, or how cassava could be transformed into traditional snacks.

> *One teacher wrote, "Children showed a very high level of curiosity. For example, S1 asked, 'Teacher, if we eat this leaf, what will it become?' when looking at cassava leaves, and S10 smelled red onion and said, 'It smells spicy, it makes you cry, doesn't it?'" (T1).*

> *Another reflection noted children asking, "What seeds are we planting? How long will they take to grow?" and "What is the planting medium made of, and why do we have to add fertilizer?" (T2-T3).*

These spontaneous questions spanned basic scientific reasoning (growth, soil media, watering), sensory exploration (smell and texture), and early causal explanations linking food to health and taste.

> *In one class, a teacher reported that "S11 asked, 'Miss, how does rice become nasi?' while S12 examined the shape of mung beans closely, and S13 smelled basil leaves and commented, 'It smells like the vegetables in lalapan, Miss'" (T9).*

> *Another teacher described a child wondering aloud, "Teacher, what will this sweet potato be turned into? Will it be tasty? Are you sure we can make biji salak from sweet potato? Real salak seeds are hard and can't be eaten, right?" (T7).*

Teachers perceived this curiosity as central to sustaining engagement and deepening children's understanding of food systems. They emphasized that children not only asked to gain information but also proposed hypotheses, compared experiences, and challenged ideas presented by adults.

> *For instance, one reflection summarized that children's questions ranged from "How many times a day should we water the seeds?" to "Why does this food smell like this?" and "Can this crop be sold in the market later?", revealing emerging critical thinking about growth processes, sensory properties, and everyday food practices (T2, T6, T7, T9).*

Such initiative and curiosity reflect the cognitive–affective dimension of engagement and directly support the development of children's conceptual food literacy, including understanding of food sources, processes, and properties.

Theme 3: Collaboration and Social Cooperation

PjBL units fostered substantial peer collaboration. Children shared tools such as watering cans and small shovels, helped peers who struggled with planting or gluing pictures, and took turns in tasks such as mixing batter or pounding ingredients.

> *One teacher noted that "collaboration was clearly visible when children shared planting tools, taking turns holding the watering can and small shovel" (T1), while another commented simply that children "took turns watering the plants" and "took turns in the planting process" (T2–T3).*

Collaboration was also evident when children supported peers who found tasks difficult.

> *A teacher reported that during one activity, "S13 helped S6 hold the polybag so the soil would not spill, while S3 lent a small spoon to S12 when he was pasting pictures of healthy food, and S14 and S15 took turns squeezing glue, showing good teamwork" (T9). In cooking-related activities, children naturally distributed roles: some held the bowl, others added vegetable pieces, and others stirred the mixture, waiting for their turn to mix the batter or pound ingredients together (T1, T4–T6).*

This collaborative orientation extended to shared responsibility for plants and food, including cleaning up after activities.

> *One teacher reflected that in both food-processing and planting sessions, "there was obvious cooperation and collaboration among the children: they took turns watering the plants each morning, cleaned up tools together after cooking and planting, washed dishes together and put them away, and swept the floor and school yard together" (T7).*

These behaviors align with the social components of engagement and with early food-security practices such as caring for resources, sharing tasks, and reducing waste. These collaborative patterns highlight the social dimension of engagement and help build socio-emotional skills that underpin collective food practices and communal aspects of food security.

Theme 4: Emotions and Expressive Responses

Children's emotional responses were overwhelmingly positive. Teachers described frequent smiles, laughter, and expressions of pride when children successfully completed tasks such as forming round klepon, harvesting leafy vegetables, or identifying favorite traditional foods.

> *One teacher wrote that "children's emotional expressions tended to be positive throughout the activities. Many smiled as they named their favorite foods, such as fried rice, satay, or vegetable soup. When harvesting kangkung from the mini garden, children laughed happily and felt proud to take home their own crops" (T1).*

> *Short reflections such as "They were happy and smiled when mentioning their favorite foods" and "Children were cheerful and happy after harvesting vegetables" echoed this pattern across sites (T2–T3).*

Children also expressed mixed emotions linked to curiosity, such as surprise and amusement when discovering new information about food.

> *One teacher described how, during a reflection about biji Salak made from sweet potato, children exclaimed, "Ooo, so 'biji salak' is made from sweet potato; we thought it was real salak seeds!" and commented, "I really like sweet potato, it tastes sweet. I like cassava crackers; they're tasty and crunchy; later I want to buy them with my mother" (T7).*

> *Another teacher reported that S15 smiled broadly while naming her favorite food, S12 looked proud after successfully sprinkling seeds without spilling, and S16 laughed while watching a video of children eating together in the rice field (T9).*

> *Emotional engagement was often intertwined with verbal expression and social regulation. Children eagerly shared stories about family meals and favorite dishes at home, and they also practiced self-control in social situations. For instance, one teacher highlighted that "children queued to taste the food without pushing or shoving, and when harvesting they were happy because this was a new experience for them" (T8).*

Across classrooms, children's emotions were diverse but predominantly positive, encompassing joy, pride, amusement, curiosity, and calm patience while waiting for their turn. These predominantly positive and well-regulated emotional and expressive responses form a key affective component of engagement, supporting children's sustained participation and openness to learning about food.

Theme 5: Authentic Behaviors and Meaning Making

The data revealed multiple instances of authentic behavior change and emergent reasoning related to food security and sustainability. Some children articulated simple principles of not wasting food, connected eating vegetables to being strong and

healthy, or speculated that abundant harvests could be sold at the market.

> *One teacher recorded a child saying, "If we throw food away, it's a pity, it's better to share with friends," indicating an early understanding of sustainable food practices (T1). In another class, a child remarked, "If we eat vegetables, we can be strong, right, Teacher?", showing a basic grasp of the nutritional benefits of vegetables (T4). Similarly, one child commented, "If the plants grow a lot, we can sell them at the market, can't we, Miss?", pointing to an emerging sense of household food economics (T9).*

> *Children also showed growing ecological awareness and care for their environment. A teacher described how S16 "repeatedly watched over a small plant in the corner of the classroom and reminded her friends not to step on it" (T4), illustrating attention to detail and responsibility for living things. Another reflection noted that children carefully protected seedlings in the garden, reminded friends to water them, and expressed a desire to return to the field to harvest more vegetables (T5, T7).*

Authentic behaviors were further expressed through reflective and creative comments about learning activities.

> *For example, one teacher reported a child asking, "Teacher, when will we go to the rice field again? I want to pick more kangkung," and another saying, "Teacher, it's more fun to learn outdoors and practice directly; it would be great if we could harvest every day" (T5, T7). Children also linked their classroom experiences to family life, with one child happily saying, "This is my favorite, my mother likes to cook this," while tasting a traditional dish (T8). In addition, social initiative emerged when children invited peers to participate, such as S17 telling a friend, "Let's water together so the plants grow faster!", demonstrating early leadership and collective responsibility (T9).*

Taken together, these accounts show that PjBL activities supported not only knowledge acquisition but also the internalization of values and practices related to food security, sustainability, and social responsibility. Children's unique behaviors, memorable comments, and spontaneous responses illustrate a holistic learning process in which cognitive, social, emotional, and cultural dimensions of food literacy are developed in an integrated way. In this way, children began to embed food literacy and food security in their values and everyday practices, for example through anti-food-waste attitudes, simple economic reasoning about harvests, and connections to family and cultural food identities.

Integration of Quantitative and Qualitative Findings

The integrated analysis of the quantitative and qualitative strands converges on the central role of children's engagement in local-wisdom Project-Based Learning as a key mechanism through which the intervention promotes food literacy and early food-security, related behaviors. The PLS-SEM model showed that higher levels of behavioral, social, and emotional engagement significantly predicted higher food literacy ($\beta = 0.573$, $p < .001$) and food security ($\beta = 0.447$, $p < .001$), explaining 32.8% and 19.9% of the variance in these outcomes, respectively. Qualitative themes from classroom observations, teacher interviews, and reflective journals provide concrete illustrations of what this engagement looked like in practice and how it translated into children's knowledge, skills, and everyday food practices across sites.

First, there was strong convergence between the quantitative construct of engagement and the qualitative theme of children's active participation in project activities. In the structural model, engagement was operationalized through indicators capturing children's visible involvement and affective presence in PjBL sessions, and it emerged as a robust predictor of both outcome constructs. This pattern is mirrored in teachers' descriptions of children eagerly watering plants, planting seeds, washing vegetables, stirring batter, and following the full gardening–cooking–tasting cycle with sustained attention and enthusiasm. These detailed accounts show how the "engaged child" represented in the model corresponds to children who are behaviorally involved, cognitively focused, and socially present during local-food projects, thereby creating the experiential basis for subsequent gains in food literacy and food security.

Second, the qualitative themes help clarify how engagement is converted into food literacy. The statistical association between engagement and food literacy is elaborated by narrative evidence of children's initiative and curiosity (Theme 2) and their use of explicit reasoning about food. Teachers reported that children frequently asked questions about plant growth, ingredients, cooking processes, and the health benefits of specific foods, while also proposing simple explanations and hypotheses (e.g., linking vegetables to strength and energy). Such episodes exemplify the shift from mere participation to conceptual engagement, in which children actively construct meanings about food sources, preparation, and health. These cognitive–affective processes correspond to the functional and interactive dimensions of food literacy captured quantitatively and help explain why higher engagement scores are associated with stronger food-literacy outcomes in the PLS-SEM model.

Third, the intertwined development of food literacy and food security (quantitatively reflected in their relatively high correlation, $r = 0.710$) is illuminated by qualitative evidence of collaboration, shared responsibility, and emerging sustainability reasoning. The social-cooperation theme (Theme 3) shows

children sharing tools, dividing tasks, helping peers, and jointly caring for plants, while the "authentic behaviors and meaning making" theme (Theme 5) documents spontaneous comments about not wasting food, sharing leftovers with friends, and imagining harvested vegetables being sold or cooked at home. These instances demonstrate how knowledge and attitudes about food (food literacy) are embedded within everyday practices that touch on resource use, sharing, and simple economic considerations (food security). In other words, the qualitative data depict the pathway through which understanding food and participating in food-related projects are translated into early pro-sustainability behaviors that underpin the food-security construct in the quantitative model.

The integration also reveals a productive tension between strands that points to directions for refinement. In the measurement model, the indicator representing initiative and curiosity (ENG2) showed poor psychometric performance and was removed, suggesting that, as measured, this item did not converge with the other engagement indicators. However, the qualitative findings consistently highlight initiative and curiosity as salient and pervasive features of children's participation, with children repeatedly initiating questions, explorations, and ideas without teacher prompts. This divergence suggests a limitation in how the ENG2 indicator was operationalized rather than an absence of initiative and curiosity in children's actual behavior. Mixed-methods integration thus signals a need to refine future engagement measures so that they more accurately capture this cognitive–exploratory dimension, which appears to be critical in driving conceptual food literacy.

Finally, the qualitative strand extends the quantitative results by foregrounding emotional and cultural layers that are only partially reflected in the numerical indicators. Positive emotions and expressive responses (Theme 4), such as joy, pride, amusement, and calm patience—help explain why engagement in local-food projects can be sustained over time, thereby supporting consistent participation in gardening and cooking tasks that are captured quantitatively as engagement and food-security–related behaviors. Likewise, children's references to family meals, local traditional foods, and community practices demonstrate that the intervention not only affects in-class behaviors but also resonates with home and cultural contexts. These culturally anchored meanings are not directly modelled in the PLS-SEM analysis, yet they likely contribute to the strength and durability of the observed effects. Taken together, the integrated findings support the theory of change in which culturally grounded, hands-on PjBL fosters deep engagement, which in turn cultivates food literacy and early food-security practices during the transition to elementary education.

At the same time, the integrated findings point to an important distinction between contextual specificity and transferability across the five Indonesian sites. The concrete cultural expressions of the intervention, such as the local crops planted, traditional foods prepared, market practices observed, and community food rituals discussed, were clearly shaped by the distinctive food ecologies of each region, underscoring the importance of contextual adaptation in implementation-oriented educational research. However, beneath these site-specific variations, the core pedagogical processes were remarkably consistent. Across settings, children's sustained engagement, curiosity, collaboration, emotionally positive participation, and their growing tendency to connect classroom food experiences with home and community practices emerged as common mechanisms through which the intervention supported food literacy and early food-security–related behaviors. This suggests that while the cultural content of local-food PjBL must remain context responsive, the underlying learning processes may be transferable to other early childhood settings where educators adapt project content to local foodways, available resources, and community traditions.

Table 6 summarizes the integrated interpretation of the quantitative and qualitative findings from the mixed-methods analysis. Rather than treating the PLS-SEM results and thematic analysis as separate strands, the table aligns the main statistical relationships (e.g., the predictive role of engagement and the interrelation between food literacy and food security) with the five qualitative themes that emerged from observations, interviews, and reflective journals. For each focus of integration, the table juxtaposes key model estimates with illustrative patterns in children's behaviors—such as active participation, initiative and curiosity, collaboration, emotional expressions, and authentic food-related practices—and offers a concise explanation of how these strands converge or diverge. In doing so, the table clarifies how and why engagement in local-food PjBL translates into gains in food literacy and early food-security–related behaviors, while also highlighting areas where the qualitative evidence suggests refinements to future measurement and modelling.

Table 6.
Integration of quantitative and qualitative findings

No.	Focus of integration	Quantitative findings (PLS-SEM)	Qualitative findings (themes & examples)	Integrated interpretation
1	Central role of children's engagement	Engagement is specified as an exogenous construct predicting food literacy ($\beta = 0.573$, $p < .001$; $R^2 = 32.8\%$) and food security ($\beta = 0.447$, $p < .001$; $R^2 = 19.9\%$), indicating that higher engagement is associated with better outcomes.	Theme: Children's engagement in project activities. Children actively participate in gardening and cooking projects, take roles aligned with their interests, and sustain attention throughout the sessions.	Engagement functions as a core mechanism through which local-food PjBL influences children's food literacy and early food-security–related behaviors. The "engaged child" in the model corresponds to children who are behaviorally, cognitively, and socially involved in project activities.
2	Engagement as a pathway to food literacy	Engagement shows a strong standardized path to food literacy ($\beta = 0.573$, $p < .001$), suggesting that more engaged children have higher food-literacy scores.	Theme: Initiative and curiosity. Children frequently ask questions about plant growth, ingredients, cooking processes, and health benefits; they offer explanations and link foods to strength, energy, and health.	Quantitative association between engagement and food literacy is explained by cognitive–affective processes in which children's curiosity and self-initiated questioning transform participation into conceptual understanding of food, health, and cooking.
3	Joint development of food literacy and food security	Food literacy and food security are strongly correlated ($r = 0.710$), indicating that improvements in one domain tend to co-occur with improvements in the other.	Themes: Collaboration and social cooperation and Authentic behaviors and meaning making. Children share tools, divide tasks, care for plants together, avoid wasting food, share leftovers, and imagine using harvests at home or selling them.	Food literacy (knowledge, reasoning, and attitudes) is embedded in everyday practices and social routines related to food use, sharing, and simple economic thinking, which underpin early food-security–related behaviors. The constructs reinforce each other in practice.
4	Measurement tension around initiative and curiosity	The engagement indicator capturing initiative and curiosity (ENG2) showed poor psychometric performance and was removed from the final measurement model, suggesting limited convergence with other engagement indicators.	Qualitative data consistently highlight initiative and curiosity as salient and pervasive: children initiate explorations, questions, and ideas without teacher prompts and often drive the direction of activities.	Mixed-methods integration reveals a divergence: initiative and curiosity are behaviorally central but not well captured by the removed indicator. This suggests a need to refine engagement measures to better represent this cognitive–exploratory dimension in future models.
5	Emotional and cultural layers of engagement	Emotional and cultural aspects are only indirectly represented in the engagement and food-security indicators; they are not explicitly modelled in the PLS-SEM paths.	Theme: Emotions and expressive responses, plus references to local foods, family meals, and community practices. Children display joy, pride, amusement, calm patience, and link project experiences to home and cultural contexts (e.g., traditional dishes, family eating routines).	Qualitative findings extend the quantitative model by showing that sustained engagement and early food-security practices are supported by positive emotions and culturally grounded meanings. This strengthens the theory of change: culturally embedded PjBL sustains engagement, which in turn nurtures food literacy and food-security–related behaviors.

Discussion

This study sets out to do something deceptively simple yet profoundly ambitious: to see whether a joyful, local-food project in kindergarten, planting, tending, and cooking with familiar ingredients, could genuinely move the needle on children's food literacy and early food security. Our findings suggest that it can, and that children's engagement is not merely a pleasant side effect of such projects but a central mechanism for change.

We found that engagement in local-food project-based learning (PjBL) significantly predicted both food literacy and food-security–related outcomes in young children, with moderate explanatory power for food literacy ($R^2 = 0.328$, $\beta = 0.573$, $p < .001$) and weaker but still meaningful explanatory power for food security ($R^2 = 0.199$, $\beta = 0.447$, $p < .001$). These quantitative patterns were echoed and deepened by the qualitative themes: children's sustained participation, curiosity, collaboration, emotional involvement, and teachers' reflections on how local-food projects reshaped classroom dynamics and children's everyday talk about food. Together, these findings speak to the transformative potential of child-centered, experiential food education in early childhood.

Beyond statistical significance, these findings also carry important implications for early childhood classroom practice, curriculum design, and teacher implementation. In practical terms, the statistical findings suggest that engagement should not be treated as an incidental outcome of project-based learning, but as a central instructional mechanism through which children's food literacy can be strengthened. The moderate proportion of variance explained in food literacy indicates that when children participate actively, socially, and emotionally in local-food projects, a meaningful part of their food-related learning can be shaped through classroom practice. For teachers, this means that designing opportunities for sustained participation, questioning, collaboration, and reflection is likely to be as important as the nutritional content of the activities themselves. At the same time, the weaker but still meaningful explained variance in food-security–related behaviors suggests that classroom intervention alone is unlikely to fully shape these behaviors; rather, schools may serve as an initiating context that should be reinforced through home routines, family participation, and community-based food practices, a point consistent with socio-ecological perspectives on children's food behaviors and food environments (Bronfenbrenner, 1979; Davis et al., 2021; Hawkes et al., 2020). From a curriculum perspective, the findings support the integration of culturally grounded gardening, cooking, tasting, and food-story activities into early childhood and transition-to-elementary programs as low-cost, context-sensitive strategies for building both food literacy and early sustainability-oriented habits (Ares et al., 2024; Hu & Ødemotland, 2021; Kelly & Nash, 2021).

Positioning the Findings in The Food-Literacy and Food-Systems Literature

Recent work conceptualizes food literacy in childhood as a multi-dimensional set of relational, functional, and critical competencies that develop in interaction with the broader food system (Ares et al., 2024). Our results resonate strongly with this view. The local-food PjBL activities did far more than transmit nutrition facts; they invited children to touch soil, observe plant growth, negotiate roles with peers, and transform ingredients into shared meals. These experiences align with relational and functional food-literacy competencies, learning through doing, feeling, and relating, not only through listening.

Systematic reviews show that school-based food-literacy and nutrition programs can improve knowledge, food skills, and in some cases dietary behaviors, but the field has been dominated by primary-school and adolescent interventions (Kelly & Nash, 2021; O'Brien et al., 2024; Omidvar et al., 2023). Evidence focusing specifically on preschool and kindergarten children remains limited, although emerging work has begun to clarify the unique developmental context and intervention needs of this age group (Gillic et al., 2025). By explicitly modeling young children's engagement as a latent construct and linking it statistically to food literacy and food-security outcomes, this study helps to fill that gap and underscores that early childhood is not "too early" for meaningful food-system learning.

At the same time, our findings are consistent with, and extend, the growing body of evidence on gardening and cooking programs such as Texas Sprouts, which have shown improvements in vegetable intake and diet quality among elementary-aged children, even when anthropometric outcomes remain unchanged (Davis et al., 2021; Landry et al., 2021). Systematic reviews of children's cooking programs similarly report positive effects on food preferences, self-efficacy, and sometimes intake, while calling for better integration of theory and more robust evaluation designs (Van Der Horst et al., 2024b). Our contribution lies in bringing these insights into the early-childhood space, integrating quantitative modeling with rich qualitative documentation, and embedding the work in the specific realities of rural Indonesian communities and their local food cultures.

Engagement, Local Wisdom, and Early Food Security

Several aspects of this study offer distinctive contributions to international scholarship. First, we foreground children's engagement as a central

explanatory variable, not just a descriptive outcome. In many interventions, engagement is treated as an implementation concern, important for feasibility but rarely modeled as a mechanism. By specifying engagement as an exogenous construct and demonstrating its predictive relationship with food literacy and early food security, we add empirical weight to the argument that how children participate in learning activities is as important as what those activities contain. This aligns with broader calls in food-literacy research to design interventions that are developmentally attuned, intrinsically motivating, and contextually meaningful (Ares et al., 2024; Kelly & Nash, 2021).

Second, the intervention centers local foods and local wisdom rather than generic, globalized food messages. Global food-systems work has emphasized the need for "child-centered food systems" that connect children's real lives, cultures, and environments with healthier diets (Hawkes et al., 2020; Hollis et al., 2020). In this study, children did not only learn that vegetables are "healthy"; they planted, harvested, and cooked culturally familiar ingredients, heard stories about them, and shared them with peers. These experiences may strengthen both the emotional and cultural dimensions of food literacy, helping children to see traditional foods not as "poor people's food," but as sources of pride, comfort, and agency. In low- and middle-income settings where the coexistence of undernutrition and obesogenic food environments is increasingly common, this kind of local, asset-based approach is especially significant.

Third, we treat early food security not only as a household-level economic outcome but as a lived, child-level experience. While our indicators focus on early behaviors and attitudes rather than formal food-security scores, the qualitative data show children beginning to talk differently about food availability, waste, and sharing. This connects micro-level classroom processes to macro-level concerns about sustainable, healthy diets for children (Hawkes et al., 2020; Hollis et al., 2020). The message is hopeful: even in resource-constrained communities, early-childhood classrooms can become small but powerful laboratories for reimagining local food systems.

Human Faces Behind the Numbers

Beyond the coefficients and R^2 values, the qualitative themes remind us that these effects are carried by small, human moments. Children staying longer at the garden beds than the schedule allowed; shy children volunteering to mix batter or wash vegetables; spontaneous questions about where food comes from, why some families have "more snacks" than others, and what happens when plants do not grow. Teachers' reflective journals describe how these projects softened classroom hierarchies, allowed quieter children to shine, and created new opportunities for empathy and cooperation.

These stories matter. They exemplify what child-centered food-systems scholars describe as making healthy foods "available, affordable, appealing, and aspirational" in children's everyday environments (Downs & Demmler, 2020; Hawkes et al., 2020). When a five-year-old proudly eats a traditional vegetable dish she helped prepare, or explains to a peer why they should not waste rice, we see early traces of the relational and critical food-literacy competencies that may support healthier, more sustainable diets later in life (Ares et al., 2024).

Limitations and directions for future research

Several limitations should be acknowledged when interpreting these findings. First, the study used a multi-site quasi-experimental design in a single region, with a modest sample size. Although we controlled for key covariates and used PLS-SEM to model latent constructs, the absence of full randomization at the school level and the context-specific nature of the sample limits the generalizability of the results. Larger cluster randomized trials across diverse regions and school types, urban and rural, public and private, are needed to test the robustness and external validity of these relationships. Second, while teachers' voices feature strongly in our qualitative data, parents and caregivers were less central. Yet, preschool food literacy is deeply embedded in family practices, socio-economic conditions, and caregiving norms. Future mixed-methods work should more fully integrate caregivers' perspectives and examine how school-based local-food projects interact with, reinforce, or challenge home food environments.

Considering these limitations, we recommend several directions for future research and practice. First, researchers should design and implement larger-scale, cluster randomized trials that compare different models of local-food project-based learning across multiple provinces and school types. Such studies could systematically vary contextual factors (e.g., urban–rural settings, school resources, or local food cultures) to identify which combinations of conditions most strongly support children's engagement, food literacy, and food security–related outcomes. Second, future mixed-methods studies should deliberately position parents and caregivers as co-constructors of food-literacy interventions, for example by including home-based activities, family workshops, or community food events that are tightly linked to classroom projects. This would not only enrich our understanding of how school and home environments interact, but also help to design interventions that are more culturally grounded, socially equitable, and sustainable over time. Finally, collaborative research involving educators, health professionals, community

organizations, and local food producers could explore how early-childhood local-food projects might be embedded into broader child-centered food-system strategies at the district or national level, thereby addressing both educational and food-security goals in an integrated way.

Conclusion

This study concludes that a local wisdom-based project-based learning (PjBL) model in early childhood education can meaningfully advance both scientific understanding and practical efforts to build food literacy and early food security. Its main novelty lies in positioning children's engagement, not merely as a process variable, but as a central mechanism statistically linking culturally grounded PjBL activities to gains in food literacy and food-security–related behaviors during the kindergarten–primary transition in a Global South context. By integrating PLS-SEM with rich qualitative evidence, the study offers a robust, mixed-methods demonstration that food literacy in early childhood is socio-ecologically embedded, emerging from children's active participation in local gardening, cooking, and shared reflection rather than from information delivery alone. These findings extend international food-literacy and child-centered food-systems theory to younger age groups, under-represented regions, and low-cost classroom designs, providing a scalable pedagogical model and a theoretically grounded framework that other researchers and practitioners can adapt, test, and refine across diverse educational and cultural settings.

AI Disclosure Statement

The authors used artificial intelligence (AI) tools solely for language checking and proofreading purposes to improve grammar, clarity, and readability of the manuscript. AI tools were not used for generating research content, data analysis, interpretation of findings, or drawing conclusions. The authors take full responsibility for the content and integrity of the manuscript.

References

Alaimo, K., Chilton, M., & Jones, S. J. (2020). Food insecurity, hunger, and malnutrition. In *Present Knowledge in Nutrition* (pp. 311–326). Elsevier. https://doi.org/10.1016/B978-0-12-818460-8.00017-4

Anjani, S. Y., Bagus Setiawan, & Sofi Ayu Nur Martasari. (2024). Dampak Perubahan Iklim Terhadap Ketahanan Pangan Di Indonesia. *JURNAL PENDIDIKAN DAN ILMU SOSIAL (JUPENDIS)*, *2*(3), 46–55. https://doi.org/10.54066/jupendis.v2i3.1850

Appannah, G., Toh, J. Y., Lai, J. S., Yong, H. Y., Shariff, Z. M., Tint, M. T., Yuan, W. L., Pang, W. W., Godfrey, K. M., Tan, K. H., Yap, F., Lee, Y. S., Eriksson, J. G., & Chong, M. F. F. (2024). Dietary pattern trajectories in early childhood and their associations with patterns of maternal feeding practices in a multi-ethnic Asian cohort. *Nutrition Journal*, *23*(1), 110. https://doi.org/10.1186/s12937-024-01012-5

Ares, G., De Rosso, S., Mueller, C., Philippe, K., Pickard, A., Nicklaus, S., Van Kleef, E., & Varela, P. (2024). Development of food literacy in children and adolescents: Implications for the design of strategies to promote healthier and more sustainable diets. *Nutrition Reviews*, *82*(4), 536–552. https://doi.org/10.1093/nutrit/nuad072

Bennett, A. E., Mockler, D., Cunningham, C., Glennon-Slattery, C., & Johnston Molloy, C. (2021). A Review of Experiential School-Based Culinary Interventions for 5–12-Year-Old Children. *Children*, *8*(12), 1080. https://doi.org/10.3390/children8121080

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Corbacho-Cuello, I., & Muñoz-Losa, A. (2025). Integrating School Gardens into Teacher Education: Enhancing Future Educators' Knowledge and Confidence Through Practical Training. *Journal of Science Teacher Education*, *36*(6), 758–780. https://doi.org/10.1080/1046560X.2025.2451477

Czosnek, L., Zopf, E. M., Cormie, P., Rosenbaum, S., Richards, J., & Rankin, N. M. (2022). Developing an implementation research logic model: Using a multiple case study design to establish a worked exemplar. *Implementation Science Communications*, *3*(1), 90. https://doi.org/10.1186/s43058-022-00337-8

Davis, J. N., Pérez, A., Asigbee, F. M., Landry, M. J., Vandyousefi, S., Ghaddar, R., Hoover, A., Jeans, M., Nikah, K., Fischer, B., Pont, S. J., Richards, D., Hoelscher, D. M., & Van Den Berg, A. E. (2021). School-based gardening, cooking and nutrition intervention increased vegetable intake but did not reduce BMI: Texas sprouts - a cluster randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 18. https://doi.org/10.1186/s12966-021-01087-x

Downs, S., & Demmler, K. M. (2020). Food environment interventions targeting children and adolescents: A scoping review. *Global Food Security*, *27*, 100403. https://doi.org/10.1016/j.gfs.2020.100403

Elliott, C., Truman, E., Nelson, M. R., Scheibe, C., Hudders, L., De Jans, S., Brisson-Boivin, K., McAleese, S., Johnson, M., Walker, L., & Ellison, K. (2022). Food Promotion and Children's Health: Considering Best Practices for Teaching and Evaluating Media Literacy on Food Marketing. *Frontiers in Public Health*, *10*, 929473. https://doi.org/10.3389/fpubh.2022.929473

Firmansyah, H., Purba, E. M., Purba, R., & Rosmiati, R. (2024). Household Food Insecurity and its Association with Nutritional Status of Under Five Children in Indonesia. *Media Publikasi Promosi Kesehatan Indonesia (MPPKI)*, *7*(10), 2546–2552. https://doi.org/10.56338/mppki.v7i10.6197

Franco-Dall'Agnol, J., Amaral, A. N. M., Cruz, E. A. D., Rapacci, M., & Von Bahten, A. C. (2021). Desenvolvimento de resultados de aprendizagem usando PjBL: Uma decisão planejada em quatro disciplinas profissionalizantes (The development of learning outcomes through the PjBL: a planned decision in four professional disciplines). *Revista Eletrônica de Educação*, *15*, e3539015. https://doi.org/10.14244/198271993539

Gillic, A. M. D., Kennedy, A., & Kearney, J. M. (2025). Food literacy in preschool-aged children - influencing factors, programmes, and outcomes: A scoping review. *Eating Behaviors*, *59*, 102033. https://doi.org/10.1016/j.eatbeh.2025.102033

Gispert-Llauradó, M., Escribano, J., Ferré, N., Grote, V., Koletzko, B., Ambrosini, G., Verduci, E., Gruszfeld, D., Xhonneux, A., & Luque, V. (2025). Association between early dietary patterns and cardiometabolic health at age 8: A confirmatory analysis of the European Childhood Obesity Project. *Nutrition Journal*, *24*(1), 18. https://doi.org/10.1186/s12937-025-01080-1

Hadi, K., . D., Susantini, E., & Kuntjoro, S. (2022). The Influence of Environment-based Biology Learning Integrated with Local Wisdom and Character Education on Student's Higher Order Thinking Skills and Environmental Care Attitude. *International Journal of Early Childhood Special Education*, *14*(1), 663–672. https://doi.org/10.9756/INT-JECSE/V14I1.221079

Hair, J., & Alamer, A. (2022). Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. *Research Methods in Applied Linguistics*, *1*(3), 100027. https://doi.org/10.1016/j.rmal.2022.100027

Hawkes, C., Fox, E., Downs, S. M., Fanzo, J., & Neve, K. (2020). Child-centered food systems: Reorienting food systems towards healthy diets for children. *Global Food Security*, *27*, 100414. https://doi.org/10.1016/j.gfs.2020.100414

Hollis, J. L., Collins, C. E., DeClerck, F., Chai, L. K., McColl, K., & Demaio, A. R. (2020). Defining healthy and sustainable diets for infants, children and adolescents. *Global Food Security*, *27*, 100401. https://doi.org/10.1016/j.gfs.2020.100401

Hu, A., & Ødemotland, S. (2021). Fostering Cultural Sustainability in Early Childhood Education through a Neighbourhood Project. *Sustainability*, *13*(9), 5203. https://doi.org/10.3390/su13095203

Kelly, R. K., & Nash, R. (2021). Food Literacy Interventions in Elementary Schools: A Systematic Scoping Review*. *Journal of School Health*, *91*(8), 660–669. https://doi.org/10.1111/josh.13053

Krasovska, O., Miskova, N., & Veremchuk, A. (2020). Professional Training of Future Preschool Teachers in the Field of Artistic and Aesthetic Education by Means of Contextual Learning Technologies. *Behavioral Sciences*, *10*(2), 50. https://doi.org/10.3390/bs10020050

Landry, M. J., Van Den Berg, A. E., Hoelscher, D. M., Asigbee, F. M., Vandyousefi, S., Ghaddar, R., Jeans, M. R., Waugh, L., Nikah, K., Sharma, S. V., & Davis, J. N. (2021). Impact of a School-Based Gardening, Cooking, Nutrition Intervention on Diet Intake and Quality: The TX Sprouts Randomized Controlled Trial. *Nutrients*, *13*(9), 3081. https://doi.org/10.3390/nu13093081

Marquis, G. S., Martin, S. L., & Lartey, A. (2023). The Multiple Dimensions of Participation: Key Determinants of Nutrition Intervention Outcomes. *Current Developments in Nutrition*, *7*(5), 100001. https://doi.org/10.1016/j.cdnut.2022.100001

Mielke, J., De Geest, S., Zúñiga, F., Brunkert, T., Zullig, L. L., Pfadenhauer, L. M., & Staudacher, S. (2022). Understanding dynamic complexity in context—Enriching contextual analysis in implementation science from a constructivist perspective. *Frontiers in Health Services*, *2*, 953731. https://doi.org/10.3389/frhs.2022.953731

Mogre, V., Sefogah, P. E., Adetunji, A. W., Olalekan, O. O., Gaa, P. K., Ayettey Anie, H. N. G., & Tayo, B. (2024). A school-based food and nutrition education intervention increases nutrition-related knowledge and fruit consumption among primary school children in northern Ghana. *BMC Public Health*, *24*(1), 1739. https://doi.org/10.1186/s12889-024-19200-7

Moore Heslin, A., Furlong, H., McDunphy, A., & McAdoo, K. (2024). Hands-On Interaction with Food as a Means of Increasing Vegetable Intake in Preschool Children. *The 14th European Nutrition Conference FENS 2023*, 363. https://doi.org/10.3390/proceedings2023091363

O'Brien, K., MacDonald-Wicks, L., & Heaney, S. E. (2024). A Scoping Review of Food Literacy Interventions. *Nutrients*, *16*(18), 3171. https://doi.org/10.3390/nu16183171

Omidvar, N., Doustmohammadian, A., Shakibazadeh, E., Clark, C. C. T., Kasaii, M. S., & Hajigholam-Saryazdi, M. (2023). Effects of school-based interventions on Food and Nutrition Literacy (FNLIT) in primary-school-age children: A systematic review. *British Journal of Nutrition*, *129*(12), 2102–2121. https://doi.org/10.1017/S0007114522002811

Purkait, T. (2024). Farm to Preschool Programs and Its Impact on Children's Dietary Health: Evaluation Through Bronfenbrenner's Socio-Ecological Model. *Ecology of Food and Nutrition*, *63*(3), 191–203. https://doi.org/10.1080/03670244.2024.2327619

Rajat, Chef., Gagandeep Passi, Chef., & Sumit Kumar, Chef. (2024). The Importance of Food Education: Promoting Health, Sustainability, and Empowerment. In Dr. Harbans Lal Sharma, Dr. Bijay Kumar Swain, Mr. Divakar Maurya, Mr. Shubham Mishra, Dr. Kavita Gautam, Dr. Newtan Biswas, Mr. Hafijull Mondal, Dr. Jyoti Kumari Sharma, Dr. Abhishekh Kumar Pandey, Dr. Manish Kumar Jaisal, Dr. Parul Kalia, Dr. Madhurima Chakraborty, Dr. Vinod Kumar Cherukuri, Dr. Manmeet Singh, Dr. Nishi Priya, Dr. Deepika Patil, Dr. Mamta Agarwal, Dr. Devki Nandan Sharma, Dr. Shraddha Shukla, ... Ms. Pooja Jena (Eds), *Futuristic Trends in Social Sciences Volume 3 Book 6* (First, pp. 39–43). Iterative International Publishers, Selfypage Developers Pvt Ltd. https://doi.org/10.58532/V3BESO6P4CH1

Randby, J. S., Ogden, T., & Lien, N. (2024). Implementation and effectiveness of a school-based intervention to increase adherence to national school meal guidelines: A non-randomised controlled trial. *Public Health Nutrition*, *27*(1), e25. https://doi.org/10.1017/S1368980023002938

Russell, C. G., & Russell, A. (2025). Appetite Self-Regulation in Childhood: A Narrative Review and Conceptual Model of Processes and Mechanisms With Implications for Research and Practice. *Nutrition Reviews*, *83*(9), 1784–1799. https://doi.org/10.1093/nutrit/nuae220

Salimon, F. (2022). Experiential Learning. *International Journal of Research Publication and Reviews*, *03*(12), 2363–2366. https://doi.org/10.55248/gengpi.2022.31276

Sharp, E., Tsang, S., & Egli, V. (2025). Children's food gardening: Valuing experiential, intergenerational and multi-cultural learning. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *20*(4), 738–762. https://doi.org/10.1080/1177083X.2024.2425427

Suwannawong, P. R., Auemaneekul, N., Powwattana, A., & Chongsuwat, R. (2023). Ecological system theory and community participation to promote healthy food environments for obesity and non-communicable diseases prevention among school-age children. *Public Health Nutrition*, *26*(7), 1488–1500. Cambridge Core. https://doi.org/10.1017/S136898002300040X

Swindle, T., Bellows, L. L., Mitchell, V., Johnson, S. L., Shakya, S., Zhang, D., Selig, J. P., Whiteside-Mansell, L., & Curran, G. M. (2022). Predictors of sustainment of two distinct nutrition and physical activity programs in early care and education. *Frontiers in Health Services*, *2*, 1010305. https://doi.org/10.3389/frhs.2022.1010305

Torres, N. A. M. D. M., Vidal, S. C., & Fuzaro, T. C. (2018). Project-Based Learning in Food Safety Teaching. *Revista Ciências Humanas*, *11*(2). https://doi.org/10.32813/rchv11n22018artigo8

Ülker, M. T., Elmacıoğlu, F., Büyükateş, H. S., Özdemir, A., Kuşcu Sezen, H., & Gündüz, S. N. (2024). The effect of sustainable food literacy education on primary school nutrition attitudes and behaviours. *Toros University Journal of Food, Nutrition and Gastronomy*, *3*(1), 29–34. https://doi.org/10.58625/jfng-2472

Van Der Horst, K., Smith, S., Blom, A., Catalano, L., Costa, A. I. D. A., Haddad, J., & Cunningham-Sabo, L. (2024b). Outcomes of Children's Cooking Programs: A Systematic Review of Intervention Studies. *Journal of Nutrition Education and Behavior*, *56*(12), 881–892. https://doi.org/10.1016/j.jneb.2024.08.002

Zaki, A., Mulbar, U., Husniati, A., & Naufal, M. A. (2024). Integrating Local Wisdom with Project-Based Learning to Enhance 21st-Century Skills in the Society 5.0 Era. *Journal of Ecohumanism*, *3*(7), 1821–1831. https://doi.org/10.62754/joe.v3i7.4341