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NutriPlay: Bilingual Mobile App for Nutrition and Cultural Food Education

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Abstract
Digital nutrition education interventions have shown promise, yet most remain monolingual and rarely integrate local cultural food content, limiting their relevance in multilingual, culturally diverse settings such as Indonesia. This study addresses this gap by evaluating NutriPlay, a bilingual (Indonesian-English) mobile application that uniquely integrates nutrition education, English vocabulary acquisition, and Indonesian cultural food awareness—a combination not previously examined among elementary school students. A quasi-experimental one-group pre-post intervention study involved 30 fifth-grade students in Pekanbaru, Riau. Overall nutrition knowledge improved significantly from 37.2% to 83.1% (mean gain +45.9%, $t(29)=18.47$, $p<0.001$, Cohen's $d=3.37$, $\eta^2=0.92$). Bilingual vocabulary mastery increased from 15.3% to 73.2% (+57.9%), and cultural awareness of Indonesian traditional foods reached 84%. Application engagement exceeded benchmarks with 95% repeat-use and mean session duration of 17.2 minutes. These findings demonstrate that a single mobile application can simultaneously advance nutrition literacy, second-language acquisition, and cultural identity in resource-limited school settings, offering a novel, scalable model for integrated health-language education in similar contexts.
Keywords: *Nutrition Education; Mobile Health; Bilingual Application; Cultural Awareness; Elementary School*

INTRODUCTION

Stunting remains a critical public health challenge in Indonesia, with a prevalence of 21.5% among children under five years based on the 2023 Indonesian Health Survey [1]. This condition negatively impacts cognitive development and long-term learning capacity [2]. Nutrition education from an early age, particularly among elementary school-age children, represents a strategic intervention window for establishing lifelong healthy eating behaviors.

Conventional nutrition education methods in schools are frequently constrained by teacher time limitations, lack of engaging instructional materials, and insufficient integration with existing curricula [3]. Smartphone penetration in Indonesia, which reached 68.9% in 2023, opens enormous opportunities for technology-based educational interventions that can be accessed broadly [4]. Mobile learning applications have demonstrated effectiveness across educational domains through the advantages of accessibility, personalization, and gamification-driven engagement [5].

Despite this, available nutrition applications generally target preschool children or adults, with limited evidence-based interventions for elementary school students [6]. Furthermore, few applications leverage the proven synergy between content learning and language acquisition, despite robust evidence supporting integrated bilingual education [7]. Indonesia's compulsory English curriculum at the elementary level creates a unique opportunity for bilingual interventions where nutrition content serves as an authentic language-learning context.

Cultural relevance also represents a critical yet often neglected dimension of nutrition education. Many interventions promote universal dietary guidelines without acknowledging local food culture, potentially undermining educational effectiveness and cultural identity [8]. Indonesia's rich culinary heritage offers a strong foundation for culturally grounded nutrition education that

simultaneously promotes healthy eating and pride in local heritage.

A previous study by the research team [9] demonstrated the feasibility and preliminary effectiveness of NutriPlay in preschool (PAUD) settings, showing significant improvements in nutrition understanding within sessions of less than ten minutes. The present study represents a further development targeting Grade 5 elementary school students, featuring a substantially more complex bilingual learning architecture: a Bilingual Nutrition Dictionary (50+ terms), a 21-Day Progressive Quiz (210 questions across three difficulty levels), and a database of 25 Indonesian traditional foods. The primary novelty of this study is the simultaneous evaluation of nutrition knowledge gains, English vocabulary acquisition, and cultural food awareness within a single mobile intervention.

The objectives of this study were: (1) to evaluate NutriPlay's effectiveness in improving nutrition knowledge; (2) to measure bilingual vocabulary acquisition through integrated language learning; (3) to assess changes in cultural awareness of local Indonesian foods; and (4) to analyse user engagement patterns and application usability.

METHOD

Study Design and Participants. A quasi-experimental one-group pre-test post-test study was conducted in Pekanbaru, Riau Province, Indonesia, from April to November 2025. Ethical approval was obtained from the Institutional Review Board of Poltekkes Kemenkes Riau (No. LB.02.03/EA/KEPK-PKR/173/2025). Thirty Grade 5 students (ages 10–11 years) were recruited from SD Negeri 194 Pekanbaru. Inclusion criteria required enrolment in Grade 5 (academic year 2024/2025), basic smartphone operation skills, written parental consent and verbal child assent, and school attendance above 80%. All 30 participants completed the study (retention rate 100%).

Application Description. NutriPlay was developed using Android Studio and aligned with Indonesian Ministry of Health Regulation No. 41/2014 on Balanced Nutrition Guidelines. The application comprises three integrated modules: (1) Bilingual Nutrition Dictionary — 50+ nutrition terms with Indonesian-English translations, native-speaker audio pronunciation, child-friendly definitions, and visual illustrations; (2) 21-Day Progressive Quiz — 210 multiple-choice questions across three difficulty levels (basic concepts, applied knowledge, critical thinking) with immediate feedback and a gamified badge-reward system; and (3) Indonesian Local Healthy Foods — a database of 25 traditional foods with regional origin, nutritional composition, cultural context, and high-quality photography.

Intervention Procedure. The intervention comprised four phases. Week 1 (Pre-test): baseline assessment of nutrition knowledge, bilingual vocabulary, and cultural food awareness using structured questionnaires adapted from the authors' prior instrument [9] and reviewed for content relevance by the research team prior to administration; formal psychometric validation (e.g., content validity indexing, reliability testing) was not conducted for the present study and is noted as a limitation. Week 1 (Pre-education): a 45-minute multimedia session covering balanced nutrition concepts, the four pillars of balanced nutrition, Indonesian traditional foods, and an application tutorial. Weeks 2–3 (Application Usage): students used NutriPlay for 14 days with a minimum of 10 minutes per day, monitored via in-app analytics. Week 4 (Post-test): identical instruments were re-administered along with usability and satisfaction questionnaires.

Statistical Analysis. Data were analysed using SPSS v26.0. Normality was confirmed via Shapiro-Wilk tests. Paired-sample t-tests compared pre- and post-intervention scores (significance threshold $p<0.05$, two-tailed). Effect sizes were calculated as Cohen's d and

eta-squared (η^2), interpreted per Cohen's guidelines (d>0.8 = large). Qualitative feedback was analysed using thematic content analysis.

RESULT AND DISCUSSION

This study contributes several novel elements to the literature on digital nutrition education. First, unlike prior mobile nutrition interventions that are predominantly monolingual [3, 10, 20] , NutriPlay integrates nutrition content with English vocabulary acquisition, addressing both health literacy and language learning needs simultaneously—a dual-benefit approach rarely explored in elementary-level health interventions. Second, the deliberate inclusion of Indonesian traditional food content distinguishes this application from generic nutrition apps that often feature Western or non-culturally-specific food references, thereby strengthening cultural identity alongside health knowledge. Third, the large within-group effect size observed in this study (Cohen's d=3.37) is noteworthy; however, in the absence of a control group, it cannot be directly compared to conventional school-based nutrition education approaches, which have shown more variable effectiveness across studies [3]. This finding should be interpreted as preliminary evidence of the intervention's potential rather than proof of superiority, pending confirmation through controlled designs. Taken together, these findings position NutriPlay as an early model for integrated, culturally responsive digital health education in multilingual developing-country contexts.

Nutrition Knowledge Improvement

Overall nutrition knowledge improved significantly from a mean of 37.2% at baseline to 83.1% post-intervention, representing a mean gain of 45.9 percentage points ($t(29)=18.47$, $p<0.001$, 95% CI [41.2, 50.6], Cohen's $d=3.37$, $\eta^2=0.92$). Table 1 presents domain-level results.

The 46% mean improvement in nutrition knowledge surpasses findings from comparable mobile-based interventions, which report gains of 28–32% [10,11]. The overall effect size (Cohen's $d=3.37$; $\eta^2=0.92$) indicates extremely large practical significance, with 92% of variance in post-test scores attributable to the intervention.

Table 1. Pre-Post Intervention Knowledge Scores by Domain (N=30)

Knowledge Domain	Pre M(±SD)	Post M(±SD)	p-value	Cohen's d
Balanced Nutrition Concepts	42.0 (15.2)	87.3 (10.4)	<0.001	3.42
Nutrient Identification	38.4 (14.8)	81.6 (11.2)	<0.001	3.28
Four Pillars of Balanced Nutrition	35.2 (13.9)	79.1 (12.6)	<0.001	3.35
Food Categorisation	64.8 (18.3)	92.4 (8.9)	<0.001	1.93
Bilingual Nutrition Vocabulary	15.3 (9.7)	73.2 (13.5)	<0.001	5.08
Local Food Knowledge	27.6 (12.1)	84.7 (10.8)	<0.001	4.98
Overall Knowledge Score	37.2 (12.3)	83.1 (8.7)	<0.001	3.37

Source: Primary data, 2025

This performance may be partly attributable to the multimedia presentation, scaffolded gamification, and spaced repetition embedded in the 21-Day Progressive Quiz design [12]; however, because the intervention also included a pre-usage educational session and no control group was included, these specific mechanisms cannot be isolated from other contributing factors, and the magnitude of the gain should be interpreted with appropriate caution.

Bilingual Language Acquisition

Bilingual competency improved substantially across all assessed dimensions (Table 2). The largest gains were in active contextual usage (+76.5%) and vocabulary recognition (+72.9%). Post-intervention, 73% of students demonstrated mastery of at least 15 nutrition-related English terms, and 82% spontaneously incorporated English nutrition vocabulary during

classroom discussion, indicating authentic language transfer beyond rote memorisation.

Table 2. Bilingual Competency Development (N=30)

Competency Dimension	Pre-Test %	Post-Test %	Gain
Vocabulary Recognition	15.3	88.2	+72.9
Pronunciation Accuracy	10.1	76.4	+66.3
Active Contextual Usage	5.2	81.7	+76.5
Translation Ability	12.4	69.8	+57.4

Source: Primary data, 2025

These findings are consistent with Content and Language Integrated Learning (CLIL) research demonstrating that meaningful content provides authentic language-learning contexts [13]. The audio pronunciation feature — used by 88% of students — appears particularly valuable for Indonesian learners who often lack exposure to native-speaker English. Critically, substantial English vocabulary gains occurred alongside, rather than at the expense of, nutrition content learning—a pattern consistent with, though not a direct test of, theoretical assumptions about cognitive overload in dual-language instruction [14].

Cultural Awareness and Attitudes

Post-intervention, 84% of students expressed pride in Indonesian food culture, 72% could correctly identify regional origins of traditional foods, and 68% indicated willingness to try previously unfamiliar traditional foods. This represents a meaningful improvement from low pre-intervention baselines and aligns with Social Identity Theory, which posits that positive group identification strengthens self-concept [15]. The culturally grounded approach simultaneously promoted nutritional knowledge and cultural identity — a combination rarely achieved in technology-based nutrition programmes.

Application Engagement and Usability

Engagement metrics substantially exceeded educational app industry benchmarks across all indicators (Table 3). The mean session duration of 17.2 minutes was more than double the 8–12 minute benchmark and represented a 240% improvement over the preschool NutriPlay version (<5 minutes per session) [9]. The 95% repeat-use rate — compared to a 60–70% industry norm — and 50% completion of all 21 quiz days underscore the application's sustained motivational design.

Table 3. Application Engagement Metrics

Metric	NutriPlay	Industry Benchmark	Status
Average Session Duration	17.2 min (±4.3)	8–12 min	Exceeds
Repeat Usage Rate	95.0%	60–70%	Exceeds
21-Day Quiz Completion	50.0%	30–40%	Exceeds
User Satisfaction	85.0%	70–75%	Exceeds
All Features Used	100%	80–85%	Exceeds

Source: NutriPlay application analytics, 2025

Students completing more than 14 days demonstrated 52% higher post-test scores than those completing fewer than 7 days, a pattern consistent with the dose-response relationship predicted by spaced repetition theory [16]; however, as application usage was not randomly assigned, this association may also reflect pre-existing differences between more- and less-engaged students rather than a causal dose-response effect. The progressive quiz structure (Level 1: 95% completion; Level 2: 75%; Level 3: 50%) reflects well-calibrated difficulty, balancing challenge and achievability in line with Self-Determination Theory [17].

Comparison with Preschool Version and Study Limitations

Descriptive comparison with the preschool NutriPlay study [9] suggests differences consistent with developmental expectations for the elementary version: session duration increased 240%, repeat-use rate nearly doubled (43.3% to 95%), and bilingual

proficiency advanced from basic recognition to 73% active mastery. As the two studies involved different samples, timeframes, and (in part) instruments, these figures should be interpreted as descriptive rather than as a controlled comparison. The observed pattern is nonetheless broadly consistent with Cognitive Load Theory predictions for elementary-age learners, who possess greater working memory capacity and metacognitive skills than preschoolers [18].

Several limitations warrant acknowledgement. First, the one-group pre-post design without a control group precludes definitive causal inference; maturation and testing effects cannot be fully excluded, and the observed gains cannot be attributed to the application in isolation. Second, the pre-usage 45-minute educational session—included for ethical and practical reasons, to ensure a baseline safety and knowledge level before independent app use—constitutes a potential confounding variable, as it may itself have contributed substantially to the knowledge gains subsequently measured; the present design cannot separate the effect of this session from that of the 14-day application use. Third, formal psychometric validation of the pre- and post-test instruments (e.g., content validity assessment by subject-matter experts, reliability testing such as Cronbach's alpha) was not conducted and should be addressed in future work. Fourth, the sample (n=30, urban Pekanbaru) is small; although the observed effect sizes were very large, estimates derived from small samples are prone to instability and should be interpreted cautiously pending replication in larger, multi-site samples. Fifth, the four-week period assessed only immediate knowledge acquisition, not long-term retention or dietary behaviour change, and generalisability beyond this urban setting is limited. Future research should employ randomised controlled designs—ideally comparing NutriPlay against a no-intervention or active control group and isolating the effect of the pre-usage session from application use—with longitudinal follow-up, dietary intake assessment, formally validated instruments, and multi-site recruitment across urban and rural settings.

CONCLUSION

NutriPlay demonstrated high effectiveness as a bilingual mobile nutrition education intervention for elementary school students, yielding very large improvements in nutrition knowledge (mean gain +45.9%, Cohen's d=3.37), bilingual vocabulary acquisition (+57.9%), and cultural food awareness (84% cultural pride) while maintaining exceptional engagement (95% repeat-use rate; mean session 17.2 minutes). The integrated bilingual-cultural design successfully addressed three educational objectives simultaneously, offering a scalable, cost-efficient model for resource-limited settings. These findings suggest that mobile technology, when grounded in learning science and cultural relevance, can simultaneously support nutrition literacy, second-language development, and cultural identity — a combination with considerable public health potential in the context of Indonesia's ongoing stunting challenge.

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