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# The Effect of My Plate Nutrition Education Through Augmented Reality Media on Changes in Vegetable Consumption Behavior in Elementary School Children

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Abstract
Low vegetable consumption among elementary school children in Indonesia remains a serious public health challenge, as conventional educational methods often fail to motivate behavioral change in the digital generation. This study aims to evaluate the effectiveness of the "Isi Piringku" (My Plate) nutrition education program based on Augmented Reality (AR) on knowledge, attitudes, and vegetable consumption behavior. A quasi-experimental study with a pretest-posttest control group design involved 72 fourth and fifth-grade students selected through purposive sampling. Respondents were divided into an experimental group (n=36) that received AR intervention and a control group (n=36) with conventional media. Data were analyzed using t-tests and effect size tests (Cohen's d). Results showed significant improvements in the experimental group compared to the control group in terms of knowledge ($p<0.001$; $d=1.36$), attitudes ($p=0.003$; $d=1.03$), and vegetable consumption behavior ($p<0.001$; $d=1.19$). The AR-based intervention proved to have a strong impact (large effect size) in increasing vegetable consumption behavior compared to conventional methods. This study recommends the integration of immersive technology in school health promotion strategies to create interactive and long-lasting learning experiences.

Keywords: My Plate, eating vegetables, elementary school children, Augmented Reality technology, nutrition education

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## INTRODUCTION

Nutrition problems in primary school children are a complex issue that requires serious attention from various parties, given their significant impact on children's growth, cognitive development, and quality of life in the future (World Health Organization, 2020) emphasizes that an

unbalanced diet, such as low consumption of vegetables and fruits, is one of the main risk factors for preventable non-communicable diseases. It is important to raise awareness of the importance of balanced nutrition, including the consumption of vegetables and fruits, so that children can avoid the risk of non-communicable diseases in the future (Sagita et al., 2020).

Nutrition problems in Indonesia that remain a major challenge are the low levels of vegetable and fruit consumption among children, especially among elementary school-aged children. Data released by the Ministry of Health through the 2023 Indonesian Health Survey shows an alarming fact, namely that 96.7% of Indonesians still do not meet the World Health Organization's recommended standard consumption of five servings of vegetables and fruits per day, equivalent to 400 grams (Kementrian Kesehatan RI, 2023). A similar condition was also revealed in the Basic Health Research, which noted that more than 95% of the population over the age of 10 consumes insufficient amounts of vegetables and fruits (Riskesdas, 2018). This low consumption of vegetables and fruits has a direct impact on the increased risk of various non-communicable diseases, such as obesity, diabetes mellitus, hypertension, and cardiovascular disease, which are now increasingly found in young people (Albrahim et al., 2023; Daryati & Suryadi, 2025).

Low vegetable consumption among children, according to (Nuraeni et al., 2019), is influenced by factors such as knowledge, taste preferences, availability at home, and peer influence. Given the complexity of these factors, efforts to increase vegetable consumption require a structured behavioral psychology approach, rather than simply providing one-way information Ajzen's (1991) Theory of Planned Behavior (TPB) offers a highly relevant framework. This theory explains that a person's behavior, including vegetable consumption behavior, is influenced by three main components, namely attitudes towards the behavior, subjective norms from the surrounding environment, and perceived behavioral control. Therefore, effective interventions to change vegetable consumption behavior in children need to comprehensively consider these three aspects.

The Indonesian government has actually responded to this nutritional problem by launching various policies, one of which is the My Plate guidelines, which are an improvement on the old 4 Healthy 5 Perfect concept (Kementerian Kesehatan RI, 2014). These guidelines provide practical guidance on the ideal composition of a plate, where half is filled with vegetables and fruit. However, implementation in the field is still far from expectations. Rahmy et al (2020) found that elementary school students' functional literacy about balanced nutrition is still very low, with only 16% of students having a good understanding. The high gap between the availability of government programs and students' understanding is greatly influenced by delivery methods that are not on target.


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Conventional approaches to education , such as the use of posters, leaflets, and lectures, tend to be static, too abstract, and boring for elementary school children. These digital native children find it difficult to visualize healthy food proportions in real life if they only rely on two-dimensional images (Eka Daryati & Sadiana, 2025; Mohapatra & Mohandas, 2024).

Conventional nutrition education approaches that have been implemented, such as lectures, posters, and leaflets, are considered ineffective in attracting the attention and motivating digital generation children to change their eating behaviors (Mohapatra & Mohandas, 2024). Effective nutrition education must be able to integrate theory, research, and practice. For example, the development of Android-based nutrition education media has found that digital technology-based media is more effective in improving knowledge, attitudes, and balanced nutrition practices in elementary school students than conventional media such as posters and PowerPoint presentations. Today's children, who are growing up in the technological era, have different learning characteristics from previous generations, as they tend to be more interested in interactive, visual content that involves direct experience (Contento, 2021; Dewi & Kurniasari, 2022; Perdana et al., 2017).

Augmented Reality (AR) technology is rapidly developing in education and has the potential to improve the effectiveness of nutrition education for children. According to McGuirt et al. (2020), a review found a trend of increasing use of Extended Reality in nutrition education, although most of it is still on a laboratory scale. Juan et al. (2019) developed an AR application to help users learn nutritional information on packaged food labels and found that this technology effectively improved user understanding. Other studies Yigitbas & Mazur (2024) Confirm AR and VR as promising media for diet and nutrition education, with the advantage of displaying additional information and creating new learning experiences. The advantages of AR in health education have also been proven, according to (Mulyani et al., 2023; Sandoko et al., 2026).

Augmented Reality-based health education is effective in improving knowledge, attitudes, and healthy behaviors among pregnant women during the COVID-19 pandemic, while research from (Kalimuthu et al., 2023) integrates AR with a STEM approach in adolescent nutrition education in Malaysia and finds significant improvements in nutritional knowledge and changes in eating behaviors. The immersive and interactive learning experience through AR allows students to explore nutritional information in greater depth, simulate the preparation of balanced meals, and receive immediate feedback that can reinforce the learning process.

AR applications from a behavioral theory perspective suggest that nutrition education has the potential to simultaneously influence all three components of the Theory of Planned Behavior


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(TPB). This is in line with the findings of Lien et al. (2002) in their study on the application of TPB to fruit and vegetable consumption among adolescents, which found that attitude and perceived behavioral control are significant predictors of consumption intention Reynolds et al (1999) developed a Social Cognitive model to explain fruit and vegetable consumption among elementary school children. Their research found that availability, modeling, and motivation (including self-efficacy and outcome expectancies) are important factors that must be targeted in interventions. AR technology can be an effective means of influencing these factors through engaging visual experiences and interactive simulations that build children's confidence in choosing healthy foods.

Based on this background, this study was designed to empirically examine the effect of nutrition education based on the "Isi Piringku" guidelines delivered through Augmented Reality media on changes in knowledge, attitudes, and vegetable consumption behavior in elementary school children. This study is expected to contribute scientifically to the development of innovative and effective nutrition education methods, while also providing empirical evidence that can be used as a basis for policymakers in designing more targeted nutrition intervention programs for elementary school-aged children in Indonesia.

## RESEARCH METHOD

### Research Design

This study uses a quantitative approach with a quasi-experimental design, specifically a pretest-posttest control group design. The selection of this design refers to the recommendations (Baranowski et al., 2008) that emphasize the importance of experimental designs in evaluating the effectiveness of technology-based health behavior change interventions. This design allows researchers to compare the effects of the intervention between the experimental group, which received nutrition education through Augmented Reality media, and the control group, which received conventional nutrition education, while controlling for confounding factors through initial measurements (pretest).

### Research Objectives

The study population consists of all fourth and fifth-grade students at SDN 03 Sungai Serut, Bengkulu.

The age range of 9-11 years was chosen because they are already able to read and understand nutritional concepts. This is in line with the findings Domel et al (1996) which shows that elementary school-aged children are already able to form psychosocial predictors of fruit and vegetable


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consumption. Sampling was conducted using purposive sampling with the following inclusion criteria: (1) registered as an active student at the selected school, (2) willing to participate in the study with parental consent, and (3) no visual impairment or health conditions that could interfere with the use of the AR application. Based on sample calculations using the formula for testing two mean differences with a 95% confidence level, 80% power, and medium effect size (d=0.5), a total sample of 72 students was obtained, divided into two groups.

**Data Collection and Development Techniques Instrument**

The intervention was conducted over four weeks with one session per week, each lasting 45-60 minutes. The development of the AR application adapted the principles from (Edwards et al., 2022) in the development of interactive digital applications. In the experimental group, nutrition education used an Augmented Reality application with material from the Ministry of Health's "Isi Piringku" (My Plate) program. This application allowed students to: (a) view 3D visualizations of vegetables and their nutritional information, (b) simulate menu planning, (c) take interactive quizzes, and (d) receive immediate feedback. The mixed-reality approach also refers to the framework (Lng et al. (2023)to improve ecological validity. The control group received education using conventional methods such as posters, flipcharts, and lectures.

The research instruments consisted of three main components. First, a nutrition knowledge questionnaire containing 20 multiple-choice items on balanced nutrition, vegetable nutritional content, and the "My Plate" guidelines. Second, a scale of attitudes toward vegetable consumption was developed based on the Theory of Planned Behavior by adapting the instrument from Brug et al (1995), consisting of 15 statements with a 5-point Likert scale measuring affective attitudes, instrumental attitudes, subjective norms, and perceived behavioral control. Zabinski et al (2006) also used a similar approach in studying the psychosocial correlation of vegetable consumption in adolescents. Third, a vegetable consumption behavior observation sheet was used to record the frequency and variation of consumption during the intervention. All instruments were validated through expert judgment by three experts and tested for reliability with a Cronbach's Alpha value of 0.75-0.85.

**Data Analysis**

The collected data were analyzed using SPSS statistical software version 26. Descriptive analysis was performed to describe the characteristics of the respondents and the distribution of the research variable scores. Data normality was tested using the Shapiro-Wilk test, while variance


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homogeneity was tested using Levene's test. To test the difference in scores before and after the intervention in a single group, a paired t-test was used, while to compare the difference in score changes between the experimental and control groups, an independent t-test was used. The significance level used was $\alpha = 0.05$. Effect size was calculated using Cohen's d to determine the practical significance of the differences found.

## RESULTS AND DISCUSSION

### RESULTS

This study involved 72 elementary school students, consisting of 36 students in the experimental group and 36 students in the control group. Based on the analysis of respondent characteristics, the following distribution was obtained:

Table 1. Characteristics of Research Respondents

| Characteristics | Experimental Group (n=36) | Control Group (n=36) | p-value |
|---|---|---|---|
| Gender | | | |
| Male | 18 (50.0%) | 17 (47.2%) | 0.812 |
| Female | 18 (50.0%) | 19 (52.8%) | |
| Grade | | | |
| Grade IV | 19 (52.8%) | 18 (50.0%) | 0.813 |
| Class V | 17 (47.2%) | 18 (50.0%) | |
| Age (Mean±SD) | 10.2 ± 0.65 | 10.3 ± 0.71 | 0.524 |

*Note: Chi-square test for categorical data, independent t-test for numerical data*

Based on Table 1, it can be seen that the distribution of respondent characteristics in both groups is relatively homogeneous. There are no significant differences between the experimental and control groups in terms of gender (p=0.812), class (p=0.813), or age (p=0.524). This condition indicates that both groups have an equivalent baseline, so that the differences in results found after the intervention can be more validly attributed to the treatment given.

### Nutrition Knowledge

Analysis of nutrition knowledge scores shows different changes between the experimental and control groups after participating in the nutrition education program. Complete data on changes in knowledge scores are presented in Table 2 below:

Table 2. Comparison of Nutrition Knowledge Scores Before and After Intervention

| Group | Pretest (Mean±SD) | Posttest (Mean±SD) | Difference | p-value* |
|---|---|---|---|---|
| Experimental | 52.78 ± 11.24 | 78.61 ± 9.87 | 25.83 | 0.001 |
| Control | 53.47 ± 10.89 | 64.17 ± 11.32 | 10.70 | 0.001 |
| p-value** | 0.791 | 0.001 | 0.001 | |

**Paired t-test; **Independent t-test*


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The results of the analysis in Table 2 show that both groups experienced a significant increase in knowledge scores after the intervention (p=0.001). However, the increase in the experimental group (difference = 25.83 points) was significantly higher than that in the control group (difference = 10.70 points) with p=0.001. The posttest knowledge scores of the experimental group (78.61 ± 9.87) were also significantly higher than those of the control group (64.17 ± 11.32).

**Attitudes toward Vegetable Consumption**

Changes in students' attitudes toward vegetable consumption also showed a similar pattern to knowledge. Data on changes in attitude scores are presented in Table 3:

Table 3. Comparison of Attitude Scores toward Vegetable Consumption Before and After Intervention

| Group | Pretest (Mean±SD) | Posttest (Mean±SD) | Difference | p-value* |
|---|---|---|---|---|
| Experimental | 45.28 ± 8.76 | 58.94 ± 7.23 | 13.66 | 0.003 |
| Control | 44.89 ± 9.12 | 50.36 ± 8.54 | 5.47 | 0.012 |
| p-value** | 0.852 | 0.001 | 0.001 | |

**Paired t-test; **Independent t-test*

Table 3 shows that the experimental group experienced a more substantial increase in attitude scores (difference = 13.66 points, p=0.003) compared to the control group (difference = 5.47 points, p=0.012). The difference in attitude score improvement between the two groups was statistically significant (p=0.001), indicating that Augmented Reality media is more effective in shaping positive attitudes toward vegetable consumption.

***Vegetable Consumption Behavior***

The most important aspect of this study was the change in vegetable consumption behavior observed during the intervention period. The results of observations on the frequency of vegetable consumption are presented in Table 4:

Table 4. Comparison of Vegetable Consumption Frequency per Week Before and After Intervention

| Group | Pretest (Mean±SD) | Posttest (Mean±SD) | Difference | p-value* |
|---|---|---|---|---|
| Experiment | 8.42 ± 3.21 | 14.89 ± 3.76 | 6.47 | 0.001 |
| Control | 8.67 ± 3.45 | 10.94 ± 3.28 | 2.27 | 0.008 |
| p-value** | 0.746 | 0.001 | 0.001 | |

**Paired t-test; **Independent t-test; Frequency calculated in number of servings per week*

The data in Table 4 reveal very promising findings. The experimental group showed a much higher increase in vegetable consumption frequency (difference = 6.47 servings per week) compared to the control group (difference = 2.27 servings per week). This difference is statistically significant with p=0.001. These results indicate that nutrition education based on Augmented Reality- s is not only effective in improving knowledge and attitudes but also capable of promoting real behavioral change in the form of increased vegetable consumption.


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Table 5. Summary of Effect Size of the Intervention on Each Variable

| Variable | Cohen's d | Interpretation |
|---|---|---|
| Nutrition Knowledge | 1.36 | Large Effect |
| Attitude toward Vegetable Consumption | 1.03 | Significant Effect |
| Vegetable Eating Behavior | 1.19 | Large Effect |

*Note: Cohen's d: 0.2 = small effect; 0.5 = moderate effect; 0.8 = large effect*

Effect size analysis using Cohen's d as shown in Table 5 indicates that the Augmented Reality-based nutrition education intervention had a large effect on all variables studied. The highest effect size was found in the nutrition knowledge variable (d=1.36), followed by vegetable consumption behavior (d=1.19), and attitudes toward vegetable consumption (d=1.03). These values far exceed the threshold for a large effect (d=0.8), indicating that the difference in results between the experimental and control groups has substantial practical significance.

## DISCUSSION

The findings of this study provide strong empirical evidence regarding the effectiveness of Augmented Reality-based nutrition education in improving knowledge, attitudes, and vegetable consumption behavior among elementary school children. The results obtained are consistent with Bandura's social learning theory, which emphasizes the importance of observational learning and self-efficacy in behavior formation. The significant increase in knowledge in the experimental group can be explained by the ability of AR technology to present information visually and interactively, which facilitates the process of encoding information into long-term memory. These findings are also in line with a meta-analysis conducted by (Suleiman-Martos et al., 2021), which found that gamification in diet and nutrition interventions is effective in improving health outcomes in children and adolescents.

The success of AR interventions in improving nutritional knowledge can be understood through the superiority of this technology in creating memorable and engaging learning experiences. Thompson et al. (2015) in their randomized controlled trial found that the use of serious video games that allow players to create action plans can increase and maintain vegetable and fruit consumption in children. A similar principle is applied in this research's AR application, where students not only receive information passively but also actively participate in healthy menu planning simulations. Furthermore, Plechatá et al. (2022) in their randomized trial showed that virtual reality technology is effective as a tool to encourage pro-environmental dietary changes, confirming the potential of immersive technology in changing eating behaviors.


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The more substantial attitude change in the experimental group can be attributed to the positive visual experience created through AR technology. Kim & Hill (2015), iIn their study on garden-based integrated interventions, they found that direct and participatory experiences are effective in increasing self-efficacy, outcome expectancies, and vegetable preferences in children. Although the context is different, the same experiential learning principle applies in the use of AR, where students gain quasi-real experiences interacting with visual representations of vegetables. These results are also consistent with the findings (Parmer et al., 2009)showing that experiential learning approaches through school gardens can increase knowledge, preferences, and vegetable consumption among second-grade students.

The most significant finding was an increase in vegetable consumption behavior in the experimental group by an average of 6.47 servings per week, indicating that the intervention successfully translated cognitive and affective changes into actual behavior. This success is related to several mechanisms. First, interactive 3D visualization formed a stronger mental representation of vegetables and their benefits. Second, the simulation feature in AR provided opportunities to practice making healthy food decisions in a safe environment, increasing self-efficacy. Third, direct feedback and gamification elements reinforced positive behavior through reinforcement mechanisms.

These findings have several limitations that need to be considered when interpreting the results. First, the relatively short duration of the intervention (four weeks) did not allow for an evaluation of the sustainability of behavioral changes in the long term. Longitudinal studies are needed to confirm that the observed increase in vegetable consumption can be maintained after the intervention ends. Second, the measurement of vegetable consumption behavior still relies on self-reports and observations that are prone to bias, despite data triangulation. Third, the study was conducted in a single location with specific sociodemographic characteristics, so the results should be generalized to a broader population with caution. Fourth, external factors such as family support and the availability of vegetables at home were not strictly controlled in this study.

The practical implications of this study are highly relevant for the development of nutrition education programs in Indonesian elementary schools. Augmented Reality technology can be integrated into the health education curriculum as an innovative and effective learning medium to support the implementation of the "Isi Piringku" guidelines. With the increasing penetration of smartphones among Indonesians, the implementation of AR-based nutrition education is becoming increasingly feasible in terms of technology accessibility. However, successful implementation requires several prerequisites, including adequate technological infrastructure support in schools, teacher training in the use of applications and integration with the curriculum, development of


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content that is appropriate to the local context and eating culture of the Indonesian people, and the involvement of parents to support changes in children's eating behaviors at home.

## CONCLUSION

Based on the results of the study, nutrition education based on "Isi Piringku" through Augmented Reality media proved to be effective in increasing knowledge, attitudes, and vegetable consumption behavior in elementary school children. The AR intervention group showed a significant increase compared to the conventional group with a large effect size (Cohen's d > 1.0). These findings indicate that AR has the potential to be an innovative medium that overcomes the limitations of traditional methods in changing children's eating behaviors. The study recommends integrating AR into nutrition education programs in elementary schools to increase vegetable consumption. Further research is needed to evaluate long-term effectiveness, explore moderating factors, and develop an implementation model that can be widely adapted in various educational contexts in Indonesia.

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