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Development of the Android-Based My Edu-VegFruit Application to Increase Vegetable and Fruit Consumption in Teenagers

Pengembangan Aplikasi My Edu-VegFruit *Berbasis Android untuk Meningkatkan Konsumsi Sayur dan Buah pada Remaja*

Esi Emilia[1]*, Nur Azlina Mohamed Mokmin[2], Zulfa Nur Hanifa[1], Juliarti Juliarti[1]

[1]Nutrition Study Program, Faculty of Engineering, Universitas Negeri Medan, Medan, Indonesia
[2]Center for Teaching Technology and Multimedia, Universiti Sains Malaysia, Malaysia

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Correspondent:
Esi Emilia
esiemilia@unimed.ac.id

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ABSTRACT

Background: Many adolescents are unaware of the importance of consuming sufficient vegetables and fruits for maintaining good health. One of the contributing factors is their lack of understanding about how to assess their daily vegetable and fruit intake to meet nutritional needs. Therefore, there is a need to develop an Android-based application to help increase vegetable and fruit consumption among adolescents.
Objectives: To develop the android-based "My Edu-VegFruit" application as a guide to understand and increase vegetable and fruit consumption in adolescents.
Methods: The study was conducted from March to November, 2024 at the Faculty of Engineering, State University of Medan. The research sample consisted of 120 students from the 2022 Nutrition Study Program cohort, selected through purposive sampling. This research employed a research and development (R&D) method using the Four-D model.
Results: The define phase analysis revealed that only 20% of the sample understood their daily vegetable requirements, and 48.9% understood their fruit needs. A total of 87% of respondents expressed the need for the application. The identification phase determined the content to be included in the application. During the design phase, a complete storyboard for the application, including supporting features, was created according to the research objectives. The develop phase involved media and material validation by experts, yielding feasibility ratings of 92% from material experts and 91.67% from media experts, both categorized as highly feasible. In the disseminate phase, the application trial showed an increase in knowledge about vegetable and fruit requirements to 80%. Additionally, 90% of the sample reported satisfaction with the application.
Conclusions: The "My Edu-VegFruit" application is considered highly feasible as a guide for calculating vegetable and fruit requirements among adolescents. It can also serve as an educational tool for nutrition education on vegetables and fruits.

INTRODUCTION

Adolescence is a transitional period marked by physical and psychological changes from childhood to adulthood. According to the World Health Organization (WHO), adolescence spans the ages of 12 to 24 years. During this transitional phase, adolescents undergo significant changes, particularly in their physical and psychological development, which can directly affect their health and nutritional status. Adolescents are a vulnerable group prone to undernutrition due to dietary patterns characterized by low intake of carbohydrates, protein, minerals, and fiber, alongside excessive consumption of foods high in fat, sugar, and salt[1]. These changes are often associated with lifestyle modifications that significantly influence adolescents' dietary habits[2]. Social interactions, especially with peers, further impact food choices, leading adolescents to favor instant or processed foods with little regard for nutritional value[3].

The 2018 Basic Health Research Survey (Riskesdas) reported that 95.5% of Indonesian children aged over five years consumed less than five servings of fruits and vegetables per day. Only 24.3% of urban and 13.2% of rural adolescents in Indonesia meet the daily recommended intake of fruits and vegetables [4]. Adolescents generally consume insufficient amounts of protein, fruits, and vegetables while frequently consuming sodium-rich and fast foods[5]. Similarly, the 2017 Youth Risk Behavior Survey (YRBS) conducted by the U.S. Department of Agriculture (USDA) found that only 7.1% of high school students met USDA recommendations for fruit intake and a mere 2.0% for vegetable intake[6]. Studies conducted across various countries reveal that school-going adolescents rarely

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consume fruits and vegetables but frequently consume carbonated beverages and fast food[7]. Among Indonesian adolescents, the average fiber intake is 6 ± 2.5 g/day, significantly lower than the WHO recommendation of 25 g/day [8].

Inadequate fruit and vegetable intake leads to deficiencies in essential nutrients such as vitamins, minerals, and fiber, which disrupt the acid-base balance in the body and increase the risk of various diseases[9]. Low intake of animal protein, fruits, and vegetables is associated with high rates of anemia among adolescents[10]. Insufficient fruit and vegetable consumption is also linked to improper eating patterns and reduced body mass, particularly among overweight and obese individuals[11]. Adolescents with inadequate intake of fruits, vegetables, and other nutrient sources are at risk of nutritional problems.

Another consequence of low fiber intake is constipation. Previous research on students from the Faculty of Medicine at UMI revealed that 94.42% of participants reported low fiber consumption and experienced constipation[12]. An imbalance of nutrients consumed by adolescents often leads to health issues, particularly digestive problems. Studies have shown that insufficient intake of fiber and fluids, combined with high fat consumption, contributes to constipation. Constipation is characterized by impaired movement of food residue in the digestive tract, resulting in irregular bowel movements. The prevalence of constipation among adolescents is higher than that in adults, reaching approximately 24%[13].

Adolescents' dietary patterns tend to be unbalanced, focusing primarily on high-calorie, low-nutrient foods. Research indicates a significant association between household income and adolescent girls' nutritional intake, with lower-income households being linked to lower energy, protein, fat, carbohydrate, iron, zinc, and vitamin A intake among adolescent girl [14]. Adolescent dietary patterns are predominantly characterized by nutrient-poor foods, with only a small proportion of their diet comprising foods rich in macro- and micronutrients[10,15].

Adolescents' dietary patterns tend to prioritize energy fulfilment over balanced nutrition. Most adolescents eat primarily to satisfy hunger, often due to a lack of nutritional education within this age group. Their diets are typically nutrient-deficient, emphasizing the need for targeted nutrition education and healthier food choices[16,17]. Studies have shown that school-based nutrition and food interventions yield positive results in improving adolescents' food consumption, particularly in increasing their intake of fruits and vegetables[17,18].

An imbalance in nutrient consumption among adolescents can lead to health issues, including digestive problems. This aligns with previous research indicating that inadequate fiber and fluid intake, combined with high fat consumption, contributes to constipation. Constipation is characterized by impaired movement of food residues in the digestive tract, leading to irregular bowel movements. The prevalence of constipation among adolescents is higher than in adults, reaching approximately 24%[4].

Adolescence is a nutritionally vulnerable period due to the increased energy requirements for growth and development. According to the 2019 Nutritional Adequacy Figures (AKG) Table, adolescents need 30–35 g of fiber daily. The WHO recommends a daily intake of 500 g of fruits and vegetables, equivalent to 3–5 servings per day. Adequate fiber consumption has positive health impacts, including reducing the risk of cardiovascular disease, diabetes mellitus, and obesity[19]. Additionally, fiber intake is beneficial in preventing digestive disorders such as constipation, hemorrhoids, and colon cancer. In Indonesia, the average fiber intake remains below the WHO recommendation of 25 g per day. Various factors contribute to low fruit and vegetable consumption in society. Previous studies have identified income, nutritional knowledge, education, food availability, and accessibility as significant determinants of low fruit and vegetable intake[20].

In the current era of globalization, technological innovations such as smartphones play a significant role in daily life. Smartphones cater to various needs, including accessing information, seeking employment, playing video games, and serving as entertainment platforms. Moreover, they can be used as educational tools in primary schools. The use of media supported by technological advancements represents an innovative, creative, and interactive approach to modern education and lifestyle[21].

Media is used to connect students and teachers and to aid in understanding topics[18]. Previous studies have shown that media effectively bridges the gap between students and teachers, facilitating comprehension of educational material[22]. Technology in education is one of the innovations that must be adopted, encompassing the use of technology as a tool to enhance classroom learning[23]. Educational media serves as an interactive learning tool. Nutrition education is utilized to improve individuals' nutritional status and eating habits. During adulthood, changes in attitudes and behaviors are most rapidly influenced by nutrition education[24]. The learning process in nutrition is significantly supported by the use of media or tools that enhance understanding[25].

Based on previous research, there are three types of learning media. The first is visual media, which relies solely on sight, such as books, maps, pictures, and journals. The second is audio media, which depends only on hearing, such as tape recorders and radio. The third is audiovisual media, which combines hearing and sight, including films, videos, and television programs[26]. Adolescents today are highly familiar with technological advancements, particularly the use of Android-based mobile phones. Using technology, particularly Android-based tools, as a medium for nutrition education is one potential solution to addressing adolescents' nutritional intake issues. Research on Android-based nutrition education media has shown high levels of acceptance and preference among users[27].

The Android platform is an open-source platform that facilitates the development of various applications. Its architecture includes key components such as Applications, Application Framework, Libraries, Android Runtime, and Kernel[28]. A well-developed system is expected to exhibit high functionality, reliability, and user-

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friendliness. Identifying an individual's fruit and vegetable needs involves qualitative and quantitative data, which simplifies analysis and presentation of relevant information.

Many adolescents are unaware of the importance of adequate fruit and vegetable consumption and lack understanding of how to assess whether their daily dietary intake meets their nutritional requirements. A preliminary survey revealed that 55.6% of students in the Nutrition Science Program at Universitas Negeri Medan were unaware of the recommended daily fiber intake from fruits and vegetables. Furthermore, 97.8% of students expressed the need for educational media to improve their understanding of fruit and vegetable consumption and to meet their daily fiber needs. Therefore, a study is needed on the "Development of the My Edu-VegFruit Android Application to Calculate Adolescents' Fruit and Vegetable Consumption and Provide Education on the Importance of Fruit and Vegetable Consumption." This application aims to raise awareness and provide insights into the dietary fiber needs of adolescents and the role of fruits and vegetables in meeting those needs.

METHODS

Application Development Method

This research was conducted in the Nutrition Science Program, Faculty of Engineering, Universitas Negeri Medan, from March to August 2024. The study population consists of students from the Nutrition Science Program, 2022 cohort, currently in their fourth semester, with a total of 120 students. The sample for this study includes 30 students who will participate in the trial of the My Edu-VegFruit application. The research employs a Research and Development (R&D) approach using the 4D development model (Define, Design, Develop, Disseminate), which is a systematic framework for creating effective and efficient products.

The define stage involves identifying fruits and vegetables commonly consumed by adolescents and conducting relevant literature studies. At this stage, the nutritional content of fruits and vegetables typically consumed by adolescents is analyzed. Additionally, an assessment of adolescents' knowledge about the need for fruit and vegetable consumption is conducted, alongside an analysis of the need for an application to calculate and monitor daily fruit and vegetable intake. The purpose of the define stage is to gain a clear understanding of user needs and preferences, ensuring the application being developed aligns with the nutritional requirements of adolescents.

The design stage focuses on creating the initial draft of the Android application, emphasizing fruit and vegetable consumption. The application was designed to be as appealing as possible to capture the interest of adolescents, ensuring they understand and use the application correctly and consistently. Key considerations in the design process include using a single dominant color as the application's signature, making it easily recognizable and memorable. The application also features attractive photos of various recipes incorporating fruits and vegetables to enhance user comprehension and interest. The "My Edu-VegFruit" application design not only facilitates the calculation of daily fruit and vegetable intake but also includes features for assessing adolescent nutritional status. This was done by measuring height and weight and applying the Body Mass Index (BMI) formula.

Calculation of Fiber Based on Daily Calorie Expenditure (Total Daily Energy Expenditure - TDEE). Fiber intake is determined based on the calories burned in a day or Total Daily Energy Expenditure (TDEE). The recommended daily fiber intake is 14 g for every 1,000 calories consumed. The formula to calculate fiber requirements is: Fiber Requirement = TDEE / 1,000 kcal × 14 g. The TDEE calculation begins with determining the Basal Metabolic Rate (BMR) adjusted for physical activity levels. To assess daily fiber adequacy, the following formula is used:

$$KGij = \frac{Bj}{100}\ x\ Gij\ x\ (\frac{BDD}{100})$$

Note:
Kgij : Nutrient Content of Component i in Food Item j with a Weight of B g
Bj : Weight of Food Item j (g)
Gij : Nutrient Content of Component i per 100 g of Edible Portion of Food Item j
BDD : Percentage of The Edible Portion of Food Item j (% BDD)

The calculated nutrient content of consumed fruits and vegetables is interpreted in Table 1, based on the Guidelines for Nutrition Officers at Community Health Centers (*Puskesmas*). The classification of fruit and vegetable consumption levels is divided into four categories: good, moderate, insufficient, and deficient.

Table 1. Classification Levels of Fruit and Vegetable Consumption

Category	Indicator
Good	≥100% of The Requirement Fulfilled
Moderate	80-99% of The Requirement Fulfilled
Insufficient	70-80% of The Requirement Fulfilled
Deficient	<70% of The Requirement Fulfilled

The database of fruits and vegetables was obtained from the 2022 Indonesian Food Composition Table (TKPI) and supplemented with data from the NutriSurvey application. The dataset includes 68 entries on fiber content in fruits, vegetables, and grains. The application design, as shown in Figure 1, features an initial menu (start) with two main options: 1) Calculating adolescent nutritional status dan 2) Calculating daily fruit and vegetable consumption. This approach employs the 24-hour recall method, commonly used in dietary surveys, requiring users to recall and record all foods and beverages consumed in the last 24 hours. This method is

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chosen for its proven effectiveness in practically and efficiently measuring daily nutrient intake.

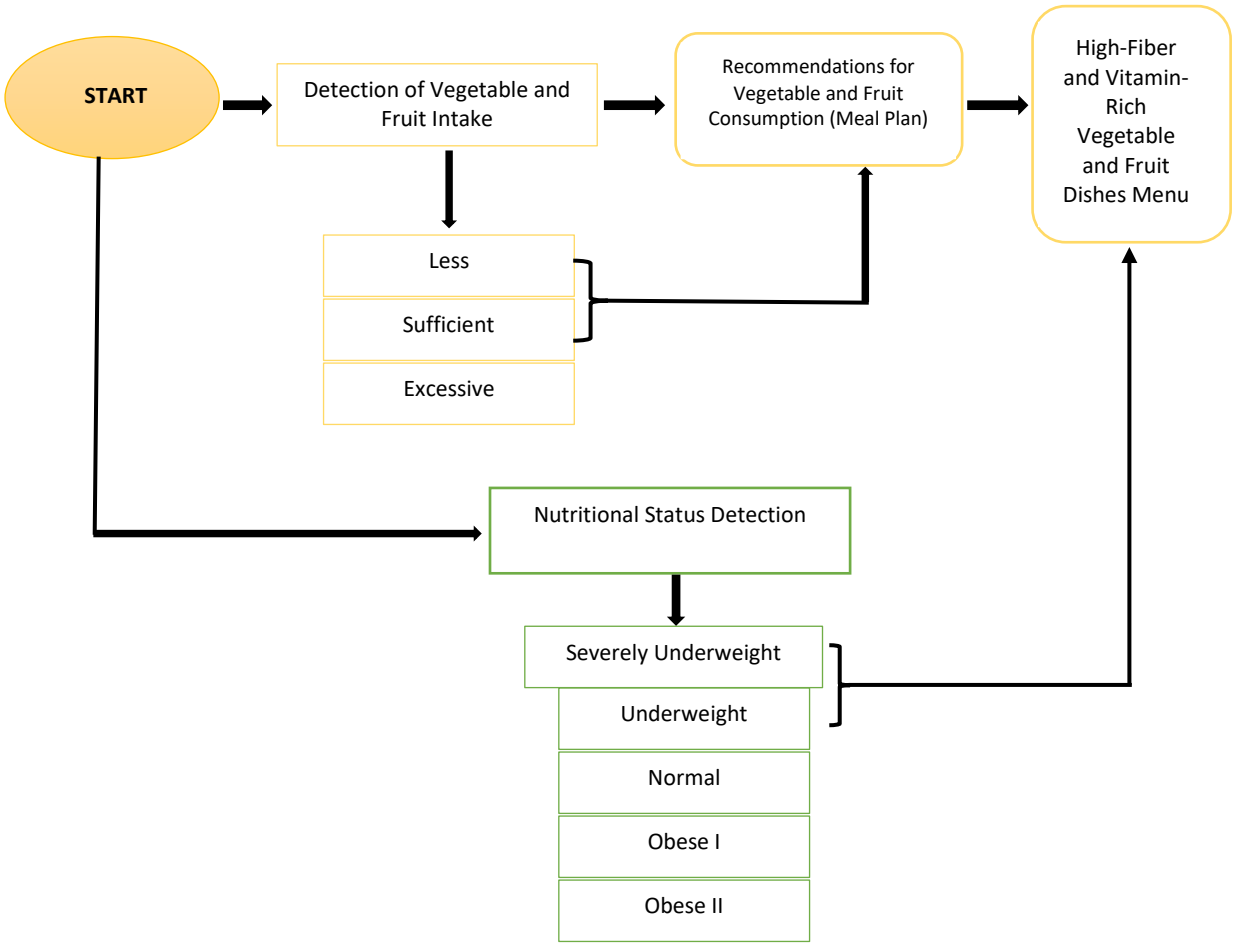

Figure 1. Initial Design of the Application

The development phase begins with realizing the designs created during the design stage. In this phase, product development involves drafting an initial prototype, which is then refined based on feedback and specific requirements. This development process also includes comprehensive evaluations to ensure that all planned elements can be effectively implemented in the final product.

Once the initial version of My Edu-VegFruit is developed, a validation stage is conducted by experts in their respective fields to ensure its quality and effectiveness. This validation involves two media experts to assess the feasibility of the media and the accuracy of the language used, as well as two content experts to ensure that the content presented is relevant, accurate, and aligned with the learning objectives. The feasibility aspects evaluated by the validators include: Content relevance, which examines the alignment of the material with the learning objectives; Language feasibility, focusing on clarity, readability, and the appropriateness of the language used; Support for materials and media, assessing the effectiveness of the instructional media used in the application; and actuality, ensuring the content aligns with the latest developments in the relevant field. The feasibility analysis is conducted descriptively based on predetermined criteria to ensure that the My Edu-VegFruit application meets the required quality standards.

The dissemination phase involves testing the application on a group of adult users using questionnaires or surveys. At this stage, respondents are asked to evaluate the application by marking the columns that correspond to their experience using the app. The purpose of this application satisfaction test is to measure how well the developed application meets the expectations and needs of its users. This stage includes a small-scale feasibility test aimed at obtaining preliminary data on user satisfaction, identifying areas for improvement before the application is introduced to a broader market.

In this study, the small-scale satisfaction test subjects were 30 students from the Faculty of Engineering at Universitas Negeri Medan. These students were selected because of their relevant background in technology and their ability to provide valuable feedback on the technical aspects of the application. The results of the satisfaction test are used as a basis for evaluating and improving the application before its wider launch. The evaluation includes various aspects, such as ease of use, clarity of instructions, visual appeal, and the application's impact on users' understanding and interest in the material presented. By gathering feedback from early

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users, necessary adjustments can be made to enhance the quality and effectiveness of the My Edu-VegFruit application.

Data Collection Technique

In this study, the data collection instrument used was a questionnaire. This measurement tool was designed to gather information from respondents through a series of questions or statements to which they must respond. The questionnaire in this research was employed to collect data on the feasibility and satisfaction level regarding the "*My Edu-VegFruit*" application. The questionnaires were categorized into three main types:

1. Content Expert Questionnaire

   This questionnaire was intended for content experts with expertise in nutrition or health education. Its purpose was to obtain feedback and evaluations on the content of the application, including the alignment of educational material with applicable nutritional standards, the relevance of the content to user needs, and the accuracy of the information presented. Content experts were expected to provide objective assessments of these aspects as well as suggestions and recommendations to improve the application's content, making it more informative and educational for adolescents. The content expert questionnaire included questions about the accuracy of nutritional status calculations, fiber requirement calculations, material depth, the attractiveness of the content for adolescents, the language style used, and the relevance of the presented material.
2. Media Expert Questionnaire

   This questionnaire was designed for media experts specializing in Android-based application design and development. The purpose of this questionnaire was to evaluate the quality of visual appearance, user interface, ease of navigation, interactivity, and application reliability. Media experts were also asked to assess technical aspects of the application, such as loading speed, compatibility with various devices, and the functionality of existing features. Their assessments were critical to ensuring that the application is not only visually appealing but also user-friendly for its target audience, namely adolescents. The media expert questionnaire included questions about the initial display, icon design, image quality, layout, size, color, font type, application effectiveness, application speed, and menu buttons within the application.
3. Student Satisfaction Response Questionnaire

   This questionnaire was aimed at students as end-users of the "My Edu-VegFruit" application. Its purpose was to determine the level of user satisfaction after using the application. The questionnaire covered various aspects such as ease of use, readability, clarity of information, perceived benefits, and user interest and motivation in utilizing the application. The students' responses provided a clear picture of their experience with the application and the extent to which it meets their needs for nutritional information and education. This satisfaction questionnaire also helped identify areas requiring improvement or refinement to enhance the application's overall quality.

Data Analysis Techniques

The descriptive analysis technique was utilized in this study, with data comprising both quantitative and qualitative types. Descriptive analysis aims to provide an overview or describe the characteristics of the research object, whether from samples or populations, based on actual conditions without generalizing or making inferences applicable to the entire population. Descriptive statistics are employed to organize, summarize, and present data in an informative manner, enabling a clearer understanding of patterns within the data. This technique allows researchers to visualize data in the form of tables, graphs, or charts and calculate statistical measures such as mean, median, mode, and frequency distribution. These steps are taken to understand general tendencies or variations within the data collected during the study.

The data collected in this study consists of two types: qualitative data and quantitative data. Qualitative data were obtained from feedback and suggestions provided by media and material experts during the application validation process. These data include comments, critiques, and recommendations highlighting aspects of the "My Edu-VegFruit" application that require improvement or refinement. Input from experts is invaluable as it offers deep insights into the application's strengths and weaknesses, serving as a foundation for further improvements and development. This qualitative data was analyzed descriptively to identify key themes and areas for enhancement that could improve the application's quality and effectiveness.

Quantitative data were represented by assessment scores derived from validation questionnaires completed by media and material experts. These validation questionnaires were designed to evaluate the application's feasibility across various aspects, such as ease of use, display quality, content relevance, and effectiveness as a learning tool. Scores provided by the experts were analyzed using descriptive statistics to calculate averages, percentages, and standard deviations, which illustrate the application's feasibility level based on expert perspectives.

The validation questionnaire utilized a Likert scale, wherein respondents were asked to indicate their level of agreement with various statements regarding the application's feasibility. Response options ranged from "strongly disagree" to "strongly agree." This scale allowed researchers to quantitatively measure the attitudes, opinions, or perceptions of experts toward the application. The data obtained from the questionnaire were analyzed to determine whether the "My Edu-VegFruit" application met the predefined feasibility criteria. Table 1 presents the detailed scoring scale used in the validation questionnaire, including assessment categories and corresponding scores for each level of agreement.

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By employing descriptive analysis techniques, this study provides a comprehensive understanding of expert perceptions regarding the feasibility and quality of the "My Edu-VegFruit" application. The results of this analysis will serve as a basis for decision-making in further improving and developing the application. The resulting application is expected to meet user needs and expectations, ensuring high satisfaction and effectiveness as a nutritional education medium for adolescents.

Table 2. Likert Scale

Response	Score
Highly Feasible/Highly Satisfied	5
Feasible/Satisfied	4
Moderately Feasible/Moderately Satisfied	3
Not Feasible/Unsatisfied	2
Very Not Feasible/Highly Unsatisfied	1

Source: [13]

Table 1 presents a Likert scale ranging from 1 to 5. Validators will assign scores to each questionnaire item. The results from the completed questionnaires will be calculated as the average percentage of each statement item using the following formula:

$$\text{Average Score} = \frac{Total\ Score\ for\ One\ Item}{Maximum\ Possible\ Score\ for\ One\ Item}\ x\ 100\%$$

The average score results for the application, as rated by the validators, will then be matched to the application feasibility categories outlined in Table 2. This categorization applies to validators with descriptions ranging from "very feasible" to "very not feasible." Meanwhile, application trial questionnaires completed by respondents will include descriptions ranging from "very satisfied" to "not satisfied."

Table 3. Feasibility Categories According to Validators and Respondents

Category (%)	Description
81-100	Highly Feasible, No Revisions Needed/Highly Satisfied
61-80	Feasible, No Revisions Needed/Satisfied
41-60	Moderately Feasible, Revisions Needed/Moderately Satisfied
21-40	Not Feasible, Revisions Needed/unsatisfied
<20	Highly Feasible, Revisions Needed/Highly unsatisfied

RESULTS AND DISCUSSIONS

Application Development Results

This study employed the Research and Development (R&D) method. The development model used was the Four-D model, which includes define, design, development, and disseminate stages. The application development steps are explained as follows:

Define Stage

This stage involved a needs analysis of the actual conditions that are the subject of the research. The define stage encompasses a series of steps to determine various types of information to ensure that the developed product aligns with the needs related to the application. The initial step involved a needs analysis for the application. This analysis was conducted through a questionnaire distributed via the *Google Forms* platform. The needs analysis results from students of the Faculty of Engineering, Universitas Negeri Medan, regarding the development of the "My Edu-VegFruit" Android application were used to assess respondents' knowledge about the daily vegetable and fruit requirements for adolescents. The identification of educational materials was carried out through a literature review. The needs analysis for the application involved 120 respondents (users).

Table 4. Respondents' Needs Analysis Results for Fiber Intake Education Media

Aspects	Percentage (%)
Respondents Who Have Never Received Nutrition Education	40.0
Respondents Unaware of Daily Fiber Intake Needs (g)	55.6
Respondents Aware of Daily Fruit Consumption Needs	48.9
Respondents Aware of Daily Vegetable Consumption Needs	20.0
Respondents Who Strongly Require Nutrition Education Media	100.0
Respondents Requiring Nutrition Education in Application Form	97.8

The needs analysis revealed that 40% of respondents had never received nutrition education about fiber needs from fruits and vegetables. Furthermore, 55.6% of respondents were unaware of the amount of daily fiber intake (g) required. Vegetables are recommended to be consumed in portions of 3–4 servings/day, while fruits are recommended at 2–3 servings/day.

Respondents' knowledge regarding daily fruit and vegetable intake was relatively low. The preliminary

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survey found that only 48.9% of respondents were aware of daily fruit requirements, and only 20% were aware of daily vegetable requirements. Educational material identification was conducted through literature review. The materials to be included in the application consist of the definition and benefits of vegetables and fruits, nutritional content, the required amounts for adolescents, and various types of vegetables and fruits.

All respondents (100%) stated that they strongly need nutrition education media about vegetable and fruit consumption for meeting fiber needs. Additionally, 97.8% of respondents expressed the need for such education in the form of an Android-based application. Respondents acknowledged the rarity of finding applications focused on vegetables and fruits. Based on the needs analysis results, it is evident that the development of a nutrition education media about vegetables and fruits using Android is essential. Previous studies have shown that nutrition education through websites significantly improves fruit and vegetable consumption among adolescents[29]. Android, as a practical educational medium, has been utilized for nutrition education, such as the SMART 5 A-Day application, which focuses on educating adolescents about fruits and vegetables[30].

The next stage involved analyzing the nutritional content of local fruits and vegetables commonly consumed. Nutritional content identification, particularly fiber and vitamin levels, was conducted using the Nutrifood application. The nutritional content data of fruits and vegetables were compiled into an Excel file. At this stage, an analysis of fruit and vegetable portions commonly consumed was also conducted, with adjustments to portion/measurement sizes in grams. This analysis is crucial for the application as a database to assess fiber adequacy levels from fruit and vegetable consumption. Additionally, the analysis at this stage included formulas for calculating fiber needs from fruit and vegetable consumption and other analyses that support the application's development needs.

Design Stage

The Design Stage in the development of the My Edu-VegFruit application focuses on the creation of the application and the design of features aimed at addressing the needs of adolescents to increase their consumption of vegetables and fruits. The My Edu-VegFruit application development process involves several steps, as follows:

1. Adding the Application Project to Firebase

   During the development of the My Edu-VegFruit application, a platform is required to assist in the application's creation. *Firebase* was utilized for this purpose to develop Android and web applications. Managed by Google, Firebase is designed to simplify the development process. *Firebase* was employed as the database management system to store the necessary data for the My Edu-VegFruit application.
2. Application Design

   After conducting a needs analysis in the Define stage, the Design stage of the My Edu-VegFruit application focuses on developing features tailored to help adolescents meet their daily fiber needs and raise awareness about the importance of consuming vegetables and fruits. The application not only provides education but also includes practical tools to support vegetable and fruit consumption in line with daily fiber requirements. The application is designed in two languages—Indonesian and English—to meet the educational needs of a diverse audience.

The features designed for this application are based on the needs analysis results. The application includes tools for calculating daily fiber requirements, tracking daily fiber intake, nutritional status calculations, nutrition education, juice recipes, user profiles, and a chat feature. Below is an explanation of each feature:

1. Daily Fiber Requirement Calculator: This feature helps users calculate their daily fiber requirements based on height, weight, age, gender, and physical activity level. The calculator provides recommendations for the amount of fiber to be consumed daily.
2. *Vegetable and Fruit Consumption Education*: This feature provides comprehensive information about the daily vegetable and fruit requirements. The education is presented through engaging texts and images explaining the importance of fulfilling daily fiber needs. Educational Content on the Benefits of Vegetables and Fruits: Users can access specific information about the benefits of various vegetables and fruits. This feature is designed to enhance users' knowledge and awareness of the positive contributions of vegetables and fruits to health. This feature also includes juice recipes made from vegetables and fruits.
3. *Fiber Intake Tracking (Recall)*: This feature allows users to record and monitor their daily fiber intake based on the types and amounts of vegetables and fruits they consume. It provides feedback on whether daily fiber needs have been met. Users can select vegetables and fruits from a menu with portion options and record what they have consumed in a day. This menu tracks consumption and the fulfillment of fiber requirements daily for each date.
4. *Nutritional Status Calculation*: This feature helps users calculate their nutritional status, which is useful for understanding their overall nutritional and health status. It serves as an additional feature that provides a comprehensive view of users' nutritional status.
5. *Chat Feature*: This feature allows users to interact with nutrition experts or fellow users to seek advice, ask questions about vegetable and fruit consumption, and share experiences. It is designed to provide social and professional support for users.
6. *Profile Feature*: This feature displays users' profiles and summarizes their total fiber adequacy for the day.

By incorporating these features, the My Edu-VegFruit application aims to serve as an innovative and practical educational tool to enhance adolescents' vegetable and fruit consumption habits.

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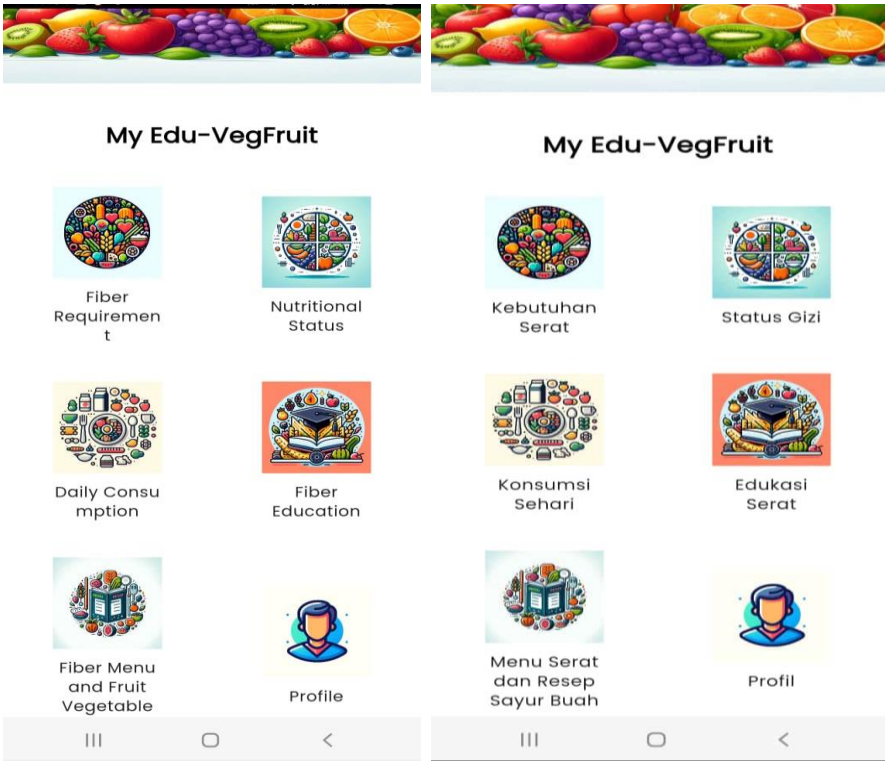

Figure 2. Initial Menu Display in English and Indonesian

Each feature in the My Edu-VegFruit application is specifically designed to address various aspects of the low consumption of vegetables and fruits among adolescents. Based on previous studies, the design stage focuses on developing features according to the materials and media required, as determined by a needs analysis. The features in the My Edu-VegFruit application aim to address specific aspects of this issue. The fiber requirement calculator and the fiber intake tracker provide practical tools for users to monitor their daily intake, while the educational feature offers the knowledge necessary for making better dietary decisions. Additionally, the chat feature enables users to receive additional support from experts and communities, which is essential for the success of long-term behavioral change.

Development Stage

During the development stage of the My Edu-VegFruit application, a prior evaluation was conducted by subject matter experts. Media validation aims to determine whether the developed media is suitable for use by respondents. The design of the My Edu-VegFruit Android application was evaluated by competent individuals (validators) in the field of media technology, such as Android applications. The aspects assessed by media expert validators include general display, text display, application operation, application effectiveness, and language. The validators consisted of two experts.

Table 4. Distribution of Validation Results Based on Assessment by Media Experts

Evaluation Criteria	Expert 1	Expert 2	Average Score
General Display Aspect	22	23	22.5
Text Display Aspect	14	15	14.5
Application Operation	18	20	19
Application Effectiveness	16	18	17
Language	10	9	9.5
Total Score	80	85	82.5
Maximum Score	90	90	90
Eligibility Percentage	88.89%	94.44%	91.67%
Criteria	Highly Suitable	Highly Suitable	Highly Suitable

Based on the validation results by media experts using questionnaires, the total validation score was 80. When calculated as a percentage of the maximum score (90), the average media eligibility percentage was 91.67%. According to the evaluation criteria, the validation results of the My Edu-VegFruit application from media experts are categorized as highly suitable, and no revisions are necessary. The study demonstrates that application products can facilitate access to information for the public by leveraging technological

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advancements[32]. The widespread use of smartphones, now owned by almost everyone, is a strategic approach to disseminating information, such as the use of Android-based comics for vegetable and fruit education among students[27]. The application enables students to easily access information, including explanations of vitamins in fruits and vegetables, complemented by quizzes with questions about fruits and vegetables to enhance their understanding[32].

Material validation was conducted to assess the relevance and accuracy of the content provided in the My Edu-VegFruit application in meeting the respondents' needs. The content presented in the application was derived from a needs analysis conducted on respondents aged 18–22 years. The material validators were two experts competent in nutritional education on topics related to daily fiber requirements.

Table 5. Validation Results Based on Assessment by Material Experts

Evaluation Criteria	Expert 1	Expert 2	Average Score
Material Relevance Aspect	20	21	20.5
Content Aspect	28	27	27.5
Presentation Aspect	20	22	21
Total Score	68	70	69
Maximum Score	75	75	75
Eligibility Percentage	90.67%	93.33%	92%
Criteria	Highly Suitable	Highly Suitable	Highly Suitable

Based on the material validation results using questionnaires, the total validation score was 69. When calculated as a percentage of the maximum score (75), the media eligibility percentage was 92% (highly suitable). The validation results from material experts recommended additional educational content, which has been incorporated into the application. Nutritional education on vegetables and fruits using Android can improve respondents' knowledge[33]. Furthermore, it is explained that the use of Android-based educational media, such as comics, significantly impacts knowledge but does not influence attitudes.

Dissemination Stage

The dissemination or distribution of the product in this study was conducted on a limited scale, targeting 30 students from the Faculty of Engineering at Universitas Negeri Medan. During the application distribution stage, satisfaction analysis was carried out using an online questionnaire (Google Form), which provided feedback in the form of satisfaction scores from respondents (students) regarding the My-EduVegFruit application. Based on the satisfaction questionnaire results, 90% of respondents expressed satisfaction with the application. Respondent satisfaction was assessed in terms of overall satisfaction, including the material provided, the application as a medium, and the ease of use of the application. Respondents noted that the application effectively provides material on vegetable and fruit requirements to meet adequate fiber intake, allows users to determine their daily fiber needs, and leverages Android technology for self-education on fiber needs and educating others.

Table 6. Respondent Satisfaction Analysis Results for the My-EduVegFruit Application

Aspects	Satisfaction Percentage (%)
Respondents Expressing Overall Satisfaction with the Application	90.0
Satisfaction with the Material Provided by the Application	90.0
Satisfaction with the Application as an Educational Tool	90.0
Satisfaction with the Ease of Use of the Application	90.0

The My-EduVegFruit application serves as an educational tool that offers convenience, satisfaction, and a new, more engaging educational experience. Android-based augmented reality technology for introducing fruits and vegetables captures students' attention, prevents boredom, and enables teachers to deliver lessons more enjoyably[34]. Nutritional education can increase knowledge and consumption of vegetables and fruits, although the increase in consumption is not statistically significant[35]. Moreover, 86% of respondents strongly agreed with using Android applications featuring augmented reality as a medium for fruit introduction due to its more engaging and realistic presentation[36].

CONCLUSIONS

Based on the development of the My Edu-VegFruit application, it can be concluded that the application was successfully designed and developed to meet the needs of its target users, specifically the students of the Faculty of Engineering at Universitas Negeri Medan. The development process followed the Four-D model: Define, Design, Development, and Disseminate. Each stage produced a functional application that is suitable as a nutrition education tool, focusing on fruit and vegetable consumption to meet fiber requirements. The application also holds potential for broader use on a larger scale to provide wider benefits in nutrition education.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

All authors declare that they have no conflicts of interest regarding this article. This study was entirely self-funded by the authors, covering all costs required for the design, development, validation, and testing of the application. This funding enabled the research to be conducted independently and objectively without any external influences that could affect the study's outcomes.

AUTHOR CONTRIBUTIONS

EE: participated in the validation process, manuscript review, and editing, ensuring the accuracy and consistency of the data presented, provided valuable feedback for manuscript improvement and refinement, supervised the testing process, and evaluated the results to ensure alignment with the planned methodology; NAMM: responsible for designing, drafting, and evaluating the My Edu-VegFruit application to ensure usability based on validator feedback, contributed to the dissemination and outcomes of the research; ZNH: oversaw research conceptualization, investigation, methodology development, data curation, manuscript review, and revisions, managed project administration, directed product development and validation processes, and ensured the final product met established quality standards; J: responsible for application trials and data analysis.

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