Interactive Multimedia Nutrition Education: Strategies To Strengthen The Free Nutritious Meal Program For Junior High School Students Based On Ngada Local Culture

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ABSTRACT

The low nutritional literacy and limited effectiveness of conventional methods are indicated by the prevalence of severely stunting (7.6%) and stunting (24.3%) among junior high school students in Ngada Regency. Consequently, the integration of interactive multimedia and local wisdom is deemed strategic in order to enhance the understanding and relevance of the material. The objective of this research is to enhance the knowledge, attitudes, and healthy eating behaviors of students by developing and evaluating the feasibility, feasibility, and effectiveness of an interactive multimedia web application for nutrition education that is rooted in the local culture of Ngada. Practicality was tested on teachers and students using ADDIE's development model, and feasibility was validated by media experts and subject matter experts. Effectiveness was assessed through a two-group quasi-experiment (pretest–posttest control group design) on 358 students, with the experimental group utilizing conventional learning applications and controls. A gain score and a paired t-test were implemented in the analysis. The results indicated that the practicality was "Very practical" (teachers 87.5%; pupils 90.4%) and that the validity was very high (media experts 90%; material experts 92%). The experimental group demonstrated substantial improvements, with a knowledge score of +24.9 (t=12.56; p<0.01), an attitude score of +23.9 (t=11.73; p<0.01), and a behavior score of +25.8 (t=13.05; p<0.01). In contrast, the controls only experienced a slight and insignificant increase (knowledge +2.2; t=1.12; p>0.05; attitude +1.8; t=0.94; p>0.05; behavior +1.2; t=1.07; p>0.05). It has been demonstrated that the incorporation of educational activities, assessments, cultural narratives, and local cuisine can enhance the relevance and engagement of learning. It has been determined that this application is practical, effective, and feasible in its ability to enhance the nutritional behavior, attitudes, and knowledge of junior high school students. The product is prepared for widespread adoption as a contextual nutrition learning model that supports national programs and the SDGs, with minor optimizations to visual consistency and media dimensions.

INTRODUCTION

Nutritional problems in junior high school students in Ngada Regency, East Nusa Tenggara, are an urgent issue to be addressed immediately. Based on 2023 SKI data, the prevalence of severely stunting reached 7.6% and stunting was 24.3%. This condition shows that there is still a low intake of balanced nutrition among adolescents, even though adolescence is an important phase for physical growth and cognitive development (Noris et al., 2022; Hargreaves et al., 2022; Bustamante et al., 2022; Jing et al., 2024). Nutritional imbalances can have a long-term impact on the quality of students' health and learning abilities. Therefore, effective nutrition education interventions in accordance with the local context are needed to increase awareness and healthy nutrition behaviors from school age.

One of the main challenges in improving nutrition literacy at the junior high school level is the low interest of students in conventional educational activities. Traditional learning methods such as lectures or the delivery of material through textbooks are often considered monotonous and less relevant to the learning habits of the digital generation (Dhaniawaty et al., 2021; Dinatha et al., 2024). Today's students are more interested in interactive and visual media that provide a hands-on and enjoyable learning experience. As a result, important nutritional messages are often not delivered optimally. Innovation is needed in learning strategies that are able to integrate technological approaches with local cultural values so that nutrition materials are easier to understand and apply in daily life.

Ngada Regency has a wealth of very diverse local food sources, such as tubers, green vegetables, and abundant sources of animal protein from people's farms. This potential is actually enough to meet the nutritional needs of students, but its utilization is still low. Many students prefer instant or fast food that is low in nutrients and high in preservatives. The lack of knowledge about the benefits of local food makes people not fully aware of the nutritional value it has (Yaacob et al., 2024). Therefore, it is important to integrate elements of Ngada culture and local wisdom in nutrition education so that students can recognize, appreciate, and utilize the food potential of their own region.

The use of information and communication technology (ICT) provides a great opportunity to overcome obstacles in the delivery of nutrition education. Web-based interactive multimedia can be an innovative solution that allows students to learn through

visual experiences, simulations, and educational games. This medium not only attracts students' attention, but also encourages their active involvement in the learning process (Friska et al., 2022; Verdonschot et al., 2023; Lamas et al., 2023). By combining technology and local content, nutrition learning can be presented contextually according to the cultural and environmental realities of Ngada students. This is expected to increase the effectiveness of government programs such as the Free Nutritious Meal Program that is being promoted.

The interactive multimedia innovation of nutrition education based on local culture in Ngada is in line with the national policy direction in the National Research Master Plan (RIRN) in the field of food and health. This program also supports the government's Asta Cita, especially the 5th agenda on improving the quality of human life and the 6th agenda on strengthening people's productivity through early education. Globally, this development contributes to the achievement of the Sustainable Development Goals (SDGs), especially SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 4 (Quality Education). Through an educational approach that is integrated with local culture, it is hoped that there will be a sustainable increase in nutrition awareness among adolescents.

This study aims to develop, test the feasibility, and assess the effectiveness of interactive multimedia nutrition education based on Ngada local culture in improving the knowledge, attitudes, and healthy eating behaviors of junior high school students. The products developed are expected to be a supporting medium for the Free Nutritious Meal Program to be more targeted and sustainable. In addition, the results of this research are expected to contribute to technology-based learning models that are relevant to the needs of students in the digital era. Through an interactive, contextual, and rooted approach to local potential, it is hoped that a healthy, intelligent, and globally competitive young generation of Ngada will be born.

RESEARCH METHODS

This research was conducted with a development research approach using the ADDIE (*Analysis, Design, Development, Implementation,* and *Evaluation*) development model. Table 1 presents the complete procedure.

Table 1. Research and Development Procedures

Yes	Phase	Activity Description	Result
1	*Analysis*	The analysis stage includes the identification of nutritional problems, eating habits, students' nutritional knowledge, as well as the evaluation of free nutritious eating programs. In addition, the potential of Ngada's local food and its nutritional content, the characteristics of students, teachers, and school principals, as well as the suitability of the curriculum with the nutrition program were also analyzed. The selection of multimedia platforms and interactive features is also determined. The analysis involved 50 students, 10 teachers, and 5 principals from five schools in Ngada Regency.	**Obtained**: Needs profile related to initial data on Ngada's local wisdom related to food, users, technical and media as well as curriculum and policies
2	*Design*	The design stage in the development of nutrition education multimedia with local content in Ngada is the process of translating the results of the analysis of local needs and wisdom into a concrete design of the multimedia application or product to be made. This stage involves visualization, structural planning, and determination of interactions in the application	**External targets**: Designing the user interface, key features and nutrition education content based on Ngada local culture
3	*Development*	The *development stage* in the development of nutrition education multimedia with local content in Ngada is the concrete implementation stage of the design that has been made at the design stage. At this stage, the development team will build a functional and interactive multimedia application or product.	**External targets**: Multimedia design of nutrition education based on local culture Ngada
4	*Implementation*	The implementation stage is the application and trial of nutrition education multimedia products for junior high school students in Ngada. The goal is to evaluate the app's performance in real-world conditions and get feedback for improvement.	**External targets**: Multimedia application of nutrition education free local culture Ngada
5	*Evaluation*	The evaluation stage in the development of Ngada locally charged nutrition education multimedia is a crucial stage to assess the effectiveness, efficiency, and attractiveness of the applications that have been developed and implemented. The evaluation is conducted based on the data collected during the implementation phase and aims to identify strengths,	**External targets**: - Product feasibility evaluation results - Increased knowledge, attitudes and behaviors towards

			weaknesses, as well as areas that need further improvement.	balanced nutritional foods

This type of research was developmental research. The product developed in this study is in the form of an Interactive Multimedia application for Ngada Local Culture-Based Nutrition Education.

The subjects of this study were junior high school grade VII students and subject teachers relevant to the material developed. The research locations were carried out at SMPN 1 Bajawa, SMPN 2 Bajawa, SMPN 5 Bajawa, SMPS PGRI Bajawa and SMP Citra Bakti. The selection of subjects and locations was carried out by considering the relationship between the characteristics of students, the availability of supporting facilities, and relevance to the research objectives.

The data collection in this study was carried out through several techniques. The observation was used in the initial stage to obtain data on the needs as a basis for analysis. The questionnaire was used to obtain assessments from experts as well as responses from students and teachers to the products developed. The test was used to measure student learning outcomes by comparing scores before and after using the product. The interviews were conducted as support to strengthen data, especially related to initial needs and final evaluation.

The collected data was analyzed using several steps. The validity of the product was analyzed based on the results of expert assessments by calculating the average score, which was then categorized as very valid, valid, or less valid. The practicality of the product was analyzed from the results of the student and teacher response questionnaire to see the extent to which the product was able to be applied in learning. The effectiveness of the product was tested using a quasi-experimental method of two groups (pre-test-post-test control group and experimental groups). This method was chosen to evaluate the effectiveness of interactive multimedia applications in improving the knowledge, attitudes, and healthy eating behaviors of junior high school students. This quasi-experimental design allowed for comparisons between the group that used multimedia applications and the group that did not use multimedia applications.

The experimental group received an intervention using an interactive multimedia application of nutrition education, which integrated local wisdom of Ngada, while the control group followed learning with conventional materials. The data collection techniques included pre-test and post-test using test instruments to measure knowledge and healthy eating habits, questionnaires and interviews to collect data on students' attitudes towards nutrition and applications, and observations to assess student engagement during learning with conventional applications and methods.

The data analysis was carried out using a t-test to compare the difference in pre-test and post-test results between the two groups. In addition, gain score analysis was used to evaluate changes in knowledge, attitudes, and healthy eating behaviors resulting from the use of multimedia applications. Thus, this study aimed to assess the extent to which Ngada's local culture-based application was able to improve students' understanding and healthy eating habits compared to conventional learning.

RESULTS OF RESEARCH AND DISCUSSION
Research Results
Adolescence is a crucial phase that requires optimal nutritional intake to support physical and cognitive growth. The interactive web application developed in this study is designed to support the nutrition learning process at the junior high school level. The material presented is not only in the form of text, but also enriched with images, audio, videos, and animations to make it more interesting and easier for students to understand. The integration of this multimedia format aims to increase appeal, strengthen understanding of concepts, and facilitate various learning styles of students.

In addition, this application prioritizes local Ngada wisdom by displaying relevant content, such as information on the nutritional value of regional foods (for example, *bose* corn, sweet potatoes, and local vegetables), healthy traditional recipes, and narratives in the form of local stories or myths related to food. The integration of the cultural context of the Ngada people's eating culture is expected not only to enrich students' nutritional knowledge, but also to foster a sense of pride and appreciation for the richness of local food as part of cultural identity.

To increase student engagement, the app is equipped with a variety of interactive features such as quizzes, gamification-based educational games, simple simulations, and case studies that fit everyday life. The interface design is made intuitive, with a simple language, so it can be easily accessed through various devices such as smartphones, laptops, and tablets through the website. Thus, this application is able to become an inclusive, interesting, and contextual learning medium for junior high school students. The interactive multimedia application for nutrition education with the title "Exciting and Healthy, Exploring the Culinary Richness of Ngada's Specialty" can be accessed at the following link: https://serudansehatngada.my.id/serudansehat/. The visualization of this application can be seen in Figure 1 below.
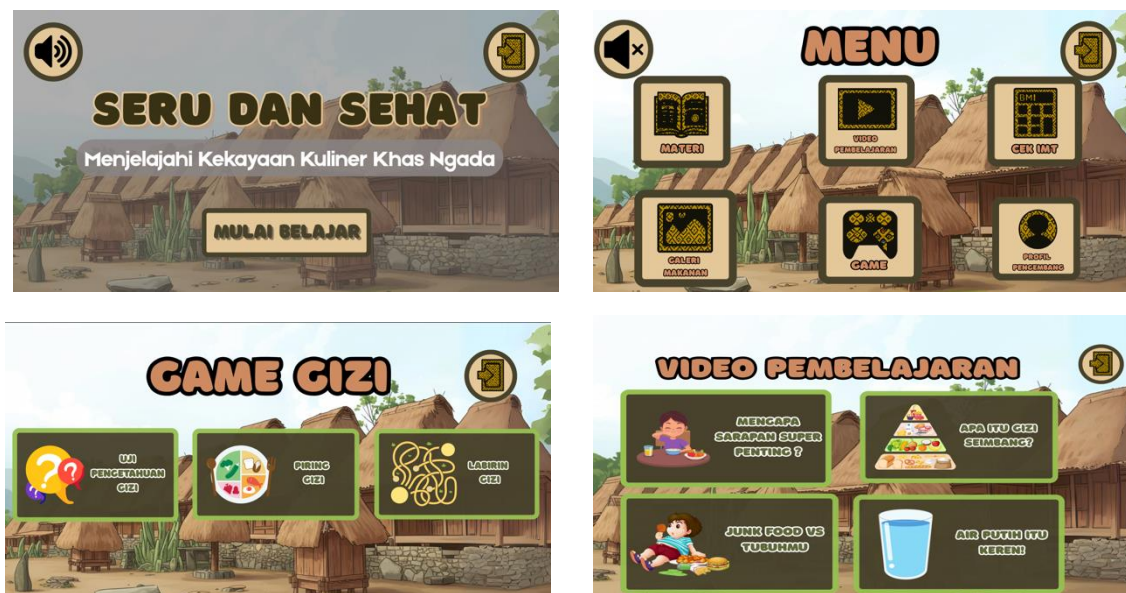
Figure 1. Interactive Multimedia Visualization of Nutrition Education

The interactive web application "Exciting and Healthy, Exploring the Culinary Richness of Ngada's Specialty" successfully integrates various multimedia elements to create an interesting and easy-to-understand learning experience for junior high school students. By utilizing images, audio, video, and animations, the app not only improves understanding of nutrition concepts but also accommodates a wide range of student learning styles. More than that, this application introduces local Ngada wisdom, making nutritional information more relevant and contextual by displaying regional foods and local stories related to food, thereby arousing a sense of pride and appreciation for local culture. Interactive features like quizzes, educational games, and simple simulations strengthen student engagement, making the app an effective, inclusive, and fun learning tool. Overall, the app not only meets the needs of nutrition education, but also provides a well-rounded and culture-based learning experience.

The assessment conducted by Media Experts on this interactive multimedia application showed very valid results, with a final score of 90% in the "Very valid" category. The app has a clean, content-focused user interface (UI), with a neat layout, good color consistency, and easy-to-read typography. Technical features such as fast load times and compatibility across devices also received positive ratings. The app also facilitates a clear and responsive learning flow, with immediate feedback and clear instructions, as well as maintaining cultural sensitivity with relevant representations of local foods.

That said, some areas need improvement, such as color consistency and icon style, and file/media size optimization to make the app more efficient. In addition, to increase interactivity, it is recommended to add elements such as progress trackers or breadcrumbs. Overall, this application is suitable for use with minor revisions on cosmetic and performance aspects, and has great potential to support nutrition education in an interesting and relevant way for junior high school students. The complete data can be seen in Table 2 below.

Table 2. Media expert questionnaire data

Yes	Aspects	Indicators (concise)	Score (1–5)
A. Display (UI/Visual)			
1	Display	Neat layout & focus content	5
2	Display	Color consistency & visual hierarchy	4
3	Display	Legible typography (title–content–caption)	5
4	Display	Icons/graphics support meaning	4
B. Technical (Stability/Performance)			
5	Technical	Fast load times on common devices	5
6	Technical	Bug-free navigation (no crash/heavy lag)	4
7	Technical	Compatible (desktop, Android; small screen)	5
8	Technical	Efficient file/media size	4
C. Interactivity & Navigation			
9	Interactivity	Responsive buttons, affordance is clear	5
10	Interactivity	Clear linear/nonlinear learning flow	4
11	Interactivity	Simple & visible instructions for use	5
12	Interactivity	Direct feedback (true/false/hint)	4
D. Content & Cultural Integration			
13	Content–Culture	Accuracy of nutritional information (trusted source)	5

Yes	Aspects	Indicators (concise)	Score (1–5)
14	Content–Culture	Relevant local food representations	4
15	Content–Culture	Cultural sensitivity (without stereotypes)	5
16	Content–Culture	The context of daily nutrition practices	4
E. Audiovisual & Accessibility			
17	AV–Access	Clear audio/narration quality	5
18	AV–Access	Narrative–text–visual synchronization	4
19	AV–Access	Important alt texts/captions available	5
20	AV–Access	Access-friendly text contrast/size	4

Total score obtained = 90 (10 points of 5, 10 points of 4)

Maximum score = 20 items × 5 = 100

Final Score = 90/100 × 100% = 90% → Category: "Very valid."

The Subject Matter Expert's assessment of this app shows very valid results, with a final score of 92% in the "Very valid" category. The app presents nutrition materials that are accurate, relevant to students' needs, and have a logical and progressive learning flow, ensuring a balance between concepts, examples, and exercises. Nutritional materials such as food portions and nutritional adequacy figures (AKG) are clearly explained and based on trusted sources. The app also pays attention to cultural relevance by showcasing local Ngada food, as well as sensitive and stereotypical-free traditional eating practices.

While the app is already excellent, some minor improvements are suggested, such as adding summaries of "takeaways" per subtopic and local case-based exercises to enrich student understanding. In addition, updating AKG data and expanding local menu examples will increase the diversity of existing cultures. With these improvements, this application will be even stronger in providing nutrition education that is accurate, relevant, and culturally sensitive, and very suitable for use as a nutrition learning medium for junior high school students. The complete data can be seen in Table 3 below.

Table 3. Data on the questionnaire of material experts

Yes	Aspects	Indicators (concise)	Score (1-5)
A. Content Eligibility			
1	Content eligibility	Scope of material according to general purpose	5
2	Content eligibility	Depth of material proportional to the target	4
3	Content eligibility	Logical & progressive order of material	5
4	Content eligibility	Balance of concepts, examples, exercises	4
B. Nutritional Science Accuracy			
5	Accuracy	Definition & concept of accurate nutrition	5
6	Accuracy	Recommended portions & proper AKG	5
7	Accuracy	Trusted source-based nutrition claims	4
C. Cultural Relevance & Locality			
8	Culture	Examples of relevant local foods	4
9	Culture	Traditional eating practices are contextualized	5
10	Culture	Cultural sensitivity (without stereotypes)	5
D. Curriculum & CP Integration			
11	Curriculum	Conform CP/TP, measurable indicator	4
12	Curriculum	The connection between topics is clear	5
E. Learning Strategies & Interactivity			
13	Strategy	Activities encourage critical thinking	5
14	Strategy	Applicable assignments (menu, budgeting, etc.)	4
F. Evaluation & Feedback			
15	Evaluation	Questions/quizzes measure the right cognitive realm	4
16	Evaluation	Clear and immediate rubric/feedback	4
G. Language & Literacy			
17	Language	Language is clear, according to the level of literacy	5
18	Language	Technical terms given glossary/simplification	5

Yes	Aspects	Indicators (concise)	Score (1-5)
H. Timeliness & References			
19	Source	Up-to-date references (≤5 years) & consistent APA	4
I. Ethics, Inclusion, & Impact			
20	Ethics–Inclusion	Considering allergies, religion, taboos	5

Total score obtained = 92

Details: 12 score points 5 (12×5=60) and 8 score points 4 (8×4=32) → 60+32 = 92

Maximum score = 20×5 = 100

Final Score = 92/100 × 100% = 92% → Category: "Very valid."

The practical test of this interactive multimedia application involved 4 teachers and 10 students as respondents, using a Likert scale of 1-5 to measure the level of agreement on various indicators related to the use of the application. The results of the assessment from the teacher show that this application has a very high average score, with a total score of 87.5% (category "Very Practical"). Indicators that scored best included local cultural relevance (4.7), device suitability (4.6), and suitability with RPP/CP/TP (4.6). The app is also rated as easy to use in the classroom, with a clear layout and easy-to-understand instructions. However, there are some areas that need optimization, such as learning time efficiency and technical stability that can be improved by optimizing media size and preload heavy elements. Further data can be seen in Table 4 and Table 5 below.

Table 4. Average score per item (G1–G4)

Yes	Indicators	Mean
1	Ease of use	4.5
2	Clarity of instructions	4.3
3	Navigation	4.4
4	Time efficiency	4.2
5	RPP/CP/TP Conformity	4.6
6	Task integration & evaluation	4.3
7	Automated feedback	4.4
8	Device compatibility	4.6
9	Technical stability	4.2
10	Visual appeal	4.5
11	Cultural relevance	4.7
12	Accessibility	4.3

Table 5. Total score per teacher

Teacher	Total	%
G1	53	88.3%
G2	50	83.3%
G3	55	91.7%
G4	52	86.7%

Total score = 53+50+55+52 = 210 out of max 240 → 87.5% (Very practical)

On the student side, the practicality test showed very positive results with a total score of 90.4%, also included in the "Very Practical" category. Students find the application easy to understand without the help of teachers (score 4.6), short and clear instructions (score 4.5), and easy navigation (score 4.5). The app's engaging display and relevance of the content to everyday life have garnered a good response from students, with many of them expressing a desire to use the app again and recommending it to their friends. These results show that the app successfully achieves the goal of engaging students and improving their understanding of basic nutrition concepts. Further data can be seen in Table 6 and Table 7 below.

Table 6. Average score per item (S1–S10)

Yes	Indicators	Mean
1	Easy to understand	4.6
2	Clear instructions	4.5
3	Easy navigation	4.5
4	Attractive display	4.4
5	Close to everyday life	4.6
6	Helps understanding	4.6
7	Quizzes help	4.5
8	The study time is just right	4.4
9	Want to wear again	4.5
10	Recommendations to friends	4.7

Table 7. Total score per student

Student	Total	%	Student	Total	%
S1	45	90%	S6	45	90%
S2	46	92%	S7	46	92%
S3	44	88%	S8	44	88%
S4	47	94%	S9	45	90%
S5	43	86%	S10	47	94%

Total score = 452 out of max 500 → 90.4% (Very practical)

Although the app scored very high, there were some suggestions for minor improvements from both groups of respondents. For teachers, it is recommended to optimize the learning time efficiency and technical stability of the application, for example by reducing the size of large media files or modifying the preload of heavier elements. For students, the app's appearance can be slightly polished to make it more comfortable to use over a longer period of time.

Overall, the results of the practicality test show that the app is worth using without the need for major revisions. With minor improvements in several aspects of cosmetics and performance optimization, this application has great potential to be used as an effective nutrition learning tool at the junior high school level. The app successfully meets the need for educational materials that are engaging, interactive, and relevant to students' daily lives, as well as supporting their understanding of nutrition and local culture.

In the effectiveness test, the research sample used 358 students who were divided into 2 groups, namely the experimental group and the control group. The results of pretest and posttest measurements for students' knowledge showed that the experimental group experienced a significant improvement after receiving the intervention. The average increase in the knowledge score was 24.9 points, with a t-test value of 12.56 and a p< significance of 0.01, indicating that this change was significant. In contrast, the control group showed only a small improvement of 2.2 points, with a t-test value of 1.12 and $p > 0.05$, meaning there was no significant change in their knowledge. The following table summarizes the results of student knowledge measurement.

Table 8. Average Pretest and Posttest Scores of Student Knowledge

Group	Pretest (M)	Posttest (M)	Changes (M)	T test	Significance
Experiment	60.5	85.4	24.9	t = 12.56	$p < 0.01$
Control	61.3	63.5	2.2	t = 1.12	$p > 0.05$

The results of the students' attitude measurements also showed significant differences between the experimental and control groups. The experimental group showed a significant improvement in their attitudes towards nutritional knowledge, with an average change of 23.9 points (t = 11.73, $p < 0.01$). Meanwhile, the control group showed only a small increase of 1.8 points, with a t-test of 0.94 and a $p > 0.05$, suggesting that these changes were not significant. The following table presents the results of student attitude measurements.

Table 9. Average Pretest and Posttest Scores of Student Attitude

Group	Pretest (M)	Posttest (M)	Changes (M)	T test	Significance
Experiment	58.2	82.1	23.9	t = 11.73	$p < 0.01$
Control	59.0	60.8	1.8	t = 0.94	$p > 0.05$

In terms of behavior, the experimental group showed very significant changes in healthy eating habits after the intervention. The mean change in student behavior was 25.8 points, with a t-test score of 13.05 and $p < 0.01$, indicating that the intervention had a large positive impact. In contrast, the control group experienced only a small increase of 1.2 points, with a t-test value of 1.07 and $p > 0.05$, meaning there was no significant change in their behavior. The following table summarizes the results of student behavior measurements.

Table 3. Average Pretest and Posttest Scores of Student Behavior

Group	Pretest (M)	Posttest (M)	Changes (M)	T test	Significance
Experiment	57.4	83.2	25.8	t = 13.05	$p < 0.01$
Control	58.0	59.2	1.2	t = 1.07	$p > 0.05$

Based on the results of the study, it can be concluded that the experimental group that received an intervention in the form of a multimedia application of nutrition education based on local culture Ngada showed a significant improvement in their knowledge, attitudes, and behaviors related to nutrition. This very significant increase shows that multimedia applications have a positive influence in improving students' understanding of nutrition, as well as encouraging changes in their behavior regarding healthy eating.

In contrast, the control group that did not receive the intervention showed only small, insignificant improvements in their knowledge, attitudes, and behaviors. This confirms that without intervention, there is no meaningful change in the aspects tested.

DISCUSSION

This study shows that the multimedia application of nutrition education based on Ngada local culture has a significant impact on improving students' knowledge, attitudes, and behaviors, especially in the experimental group that received the intervention. This significant improvement shows that the use of technology in nutrition learning can improve students' understanding of nutrition concepts and healthy eating practices (Sindi et al., 2021; Başar & Bilici, 2023; Fransisca, 2024). It also reflects the importance of integrating local cultural contexts in learning, which not only enriches the material but also creates greater relevance for students. The app combines a variety of multimedia elements, such as images, audio, video, and animation, which strengthens students' understanding, especially in understanding more complex concepts (Dahlan et al., 2023).

The success of multimedia applications in improving students' knowledge can be seen from the significant differences between the experimental and control groups, with an average increase of 24.9 points in the experimental group. This change was significant, with a t-test score of 12.56 and $p < 0.01$, suggesting that this intervention was effective in improving students' understanding of nutrition. In contrast, the control group experienced only a small improvement, confirming that without intervention, students' understanding of nutrition material did not change much. This increase in knowledge is driven by the incorporation of various multimedia formats that can accommodate different learning styles (Dixit, 2024; Ramesh & Jayashree, 2024).

The improvement of students' attitudes towards nutrition also showed very positive results after the intervention. The experimental group experienced a change of 23.9 points with a t-test score of 11.73 and $p < 0.01$, indicating that this application was effective in changing students' attitudes towards the importance of good nutrition consumption. The integration of local cultural elements, such as information about Ngada's typical foods, plays an important role in fostering a sense of pride and appreciation for local food. This increase in attitudes suggests that students are not only informed, but also begin to appreciate the cultural values that underlie healthy eating (Liu et al., 2021; Moitra et al., 2021; Almoraie et al., 2024).

In addition, significant behavioral changes in the experimental group showed a direct impact of this intervention on students' eating habits. With an average change of 25.8 points, the experimental group showed that the app was able to change their behavior to be healthier. This is evident from changes in healthier eating habits, such as choosing more nutritious foods and being more aware of the importance of a balanced diet. Live feedback and interactive features in the app, such as quizzes and educational games, reinforce these behavior changes, make learning more enjoyable and motivate students to apply the concepts learned (Dreimane, 2021; Saleem et al., 2022; Dehghanzadeh et al., 2024).

In contrast, the control group that did not accept these apps showed only a small improvement in their knowledge, attitudes, and behaviors, which was not significant. This confirms that without the use of interesting and relevant technology, students are less likely to experience meaningful changes in terms of their knowledge and healthy eating habits. A very limited increase in the control group suggests that other factors such as interest and engagement in the material are critical to learning success (Carroll et al., 2021; Ginting, 2021; Chisunum & Nwadiokwu, 2024).

This multimedia application also received positive ratings from media experts and subject matter experts, with very high validity scores (90% and 92%). This shows that the app is not only pedagogically effective, but also excellent in terms of design and fit to the needs of students. The practicality test conducted involving teachers and students also showed very positive results, with an average score of 87.5% (teachers) and 90.4% (students). This shows that the app is easy to use, relevant to student needs, and successfully increases student engagement in nutrition learning.

However, while the app is already very good, there are some suggestions for minor improvements, such as learning time optimization and technical stability. Some cosmetic areas also need slight adjustments, such as color consistency and icon style to improve user comfort. In addition, the addition of elements such as progress trackers and breadcrumbs is expected to increase interactivity and make it easier for students to follow the learning flow. These improvements will further strengthen the effectiveness of the application as an engaging, efficient, and responsive learning tool to student needs.

Overall, the results of this study show that the multimedia application of nutrition education based on local culture in Ngada is very effective in improving students' knowledge, attitudes, and behaviors towards nutrition. This application not only succeeds in conveying information in an interesting and relevant manner, but also introduces and preserves the rich local culture of Ngada in the context of nutrition education. With slight improvements to some technical and cosmetic aspects, the app has great potential to be widely used in nutrition education at the junior high school level, and can be a learning model that can be applied in different regions with different local cultural richness.

CONCLUSION

The interactive multimedia application of nutrition education developed in this study has succeeded in achieving its main goal of supporting nutrition learning at the junior high school level with an innovative approach based on local culture of Ngada. The app is effective in improving students' knowledge, attitudes, and behaviors related to nutrition through the use of multimedia elements such as images, audio, video, and animations that enrich understanding of concepts and increase student engagement. The integration of regional food and local cultural narratives adds to the relevance of the material and reinforces appreciation of local culture, making it more engaging and contextual. However, some minor improvements to the cosmetic aspects and technical optimization are still needed to improve the performance of the app. With these improvements, this application has great potential

to be widely applied in junior high schools as an effective, comprehensive, and culture-based learning tool, as well as supporting a better understanding of nutrition among students.

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