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Effect of Animated Video Based Digital Education on Anemia Knowledge among Adolescent Girls: A Pre Post Study

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Abstract–Anemia remains a major public health problem among adolescent girls, particularly in developing countries, where inadequate iron intake, menstrual blood loss, and limited health literacy contribute to its high prevalence. Insufficient knowledge regarding the causes, symptoms, and prevention of anemia often leads to poor dietary practices and low adherence to iron supplementation programs. In response to these challenges, digital health education using animated video media has emerged as an innovative and engaging strategy for improving adolescents' understanding of health-related issues. This study aimed to examine the effect of animated video–based digital education on anemia-related knowledge among adolescent girls in a senior high school setting. A quantitative pre-experimental study with a one-group pretest–posttest design was conducted involving 52 adolescent girls selected through purposive sampling at SMAN 1 Cisarua, Indonesia. Participants received an educational intervention in the form of an animated video addressing the definition, causes, symptoms, consequences, and prevention of anemia. Knowledge levels were measured before and after the intervention using a validated structured questionnaire. Data were analyzed using a paired sample t-test after confirming normal data distribution. The results demonstrated a statistically significant increase in mean knowledge scores following the intervention ($p < 0.001$), indicating a meaningful improvement in participants' understanding of anemia. These findings suggest that animated video–based digital education is an effective and accessible approach to enhancing anemia-related knowledge among adolescent girls. The use of such media may support school-based health education programs and contribute to strengthening anemia prevention efforts in adolescent populations.

Keywords: Anemia; Adolescent Girls; Health Education; Animated Video; Digital Learning

1. INTRODUCTION

Adolescence is a critical transitional period marked by substantial physical and psychological changes as individuals progress from childhood into adulthood. These developmental changes often introduce various health vulnerabilities, one of the most prevalent being anemia among adolescent girls (Gustian et al., 2024). Anemia is defined as a condition in which hemoglobin, hematocrit, or red blood cell levels fall below normal ranges, with the standard hemoglobin cut-off for adolescent girls set at above 12 g/dL (Amalia et al., 2024). Reduced hemoglobin levels impair the blood's capacity to bind and transport oxygen efficiently throughout the body, leading to physiological disruptions during an essential stage of growth (Dewi et al., 2020). This condition extends beyond a clinical issue, as chronic oxygen deficiency can influence energy levels, learning concentration, and overall quality of life during a developmental phase that plays a decisive role in shaping adolescents' functioning.

Epidemiological reports consistently indicate that anemia among adolescent girls remains a significant global health concern. The World Health Organization states that the global prevalence of anemia in this population reaches approximately 32% (World Health Organization, 2025). In Indonesia, the issue is even more prominent, with the 2018 Basic Health Research (Riskesdas) reporting a national prevalence of 48.9%, including 22.7% attributed specifically to iron deficiency among adolescent girls (Kementrian Kesehatan Republik Indonesia, 2021). A similar pattern emerges at the regional level: West Java Province records around 40% of adolescent girls experiencing anemia equivalent to roughly 1.7 million individuals (Dinas Kesehatan Provinsi Jawa Barat, 2022). In Bogor Regency, the prevalence stands at 20.9%, underscoring that anemia remains an urgent public health issue requiring structured educational interventions. These data confirm that anemia is not merely a local concern but a widespread phenomenon that demands systematic health education responses.

In addition to the epidemiological landscape, global research trends on anemia also demonstrate an increasingly broad and multidisciplinary development. A bibliometric analysis using VOSviewer on publications from 2019 to 2024 reveals that anemia-related keywords form five major clusters, including themes of nutrition and iron deficiency, chronic kidney disease, general hematological mechanisms, specific hematologic conditions such as thalassemia and myelofibrosis, as well as cancer and oncology-related therapies. The interconnectedness of keywords within these clusters indicates that anemia is not only a concern in public health and nutritional status but also plays a significant role in research involving chronic diseases, inflammation, and chemotherapy side effects. This network pattern highlights that anemia is a complex scientific issue that continues to receive global research attention, thereby reinforcing the importance of developing effective educational interventions, particularly for high-risk groups such as adolescent girls.

Anemia among adolescent girls significantly impacts their quality of life when left untreated. Common symptoms such as fatigue, weakness, dizziness, pallor, and decreased concentration may disrupt academic performance and cognitive development (Rusmaningrum, 2023). In the long term, anemia can hinder physical growth, impair brain development, weaken the immune system, and increase the risk of reproductive complications, including the possibility of delivering infants with low birth weight (Adyani et al., 2024). These findings illustrate that anemia is not merely a

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nutritional deficit but a condition that affects multiple dimensions of adolescent development, reinforcing the need for educational interventions to prevent more severe outcomes.

The vulnerability of adolescent girls to anemia is influenced by increased nutritional demands during growth, blood loss during menstruation, and dietary patterns that often lack sufficient iron intake. Adolescent girls require a higher amount of iron due to rapid physical development, while monthly menstrual cycles further elevate the risk of deficiency (Hidayah et al., 2022; Juliani et al., 2024). Additional contributing factors include low consumption of iron-rich foods, unbalanced eating habits, prolonged or heavy menstrual periods, and improper use of iron supplements, all of which exacerbate their susceptibility to anemia (Nasruddin et al., 2021). These biological and behavioral factors highlight that the risk of anemia among adolescent girls stems not only from natural physiological changes but also from limited knowledge and inadequate health practices during this developmental period.

Various government initiatives have been implemented to reduce anemia rates among adolescents, including the distribution of iron supplements and the provision of nutritious foods in schools. These programs aim to improve nutritional status and prevent iron deficiency among students (Suaib et al., 2024). However, the success of such interventions relies heavily on adolescents' understanding of anemia. Without adequate knowledge, adherence to supplement consumption and the ability to choose appropriate foods remain low. Consequently, strengthening health literacy becomes essential to ensuring the effectiveness of anemia prevention efforts (Suaib et al., 2024). Structured health education supports increased awareness, shapes risk perception, and encourages behavioral changes that promote healthier lifestyles among adolescents (K. P. Lestari et al., 2022).

With the advancement of technology, digital media has increasingly been utilized as a platform for delivering health education to adolescents. Animated videos serve as an effective medium because they present information visually, concisely, and in alignment with the learning preferences of today's youth. Such media simplifies complex material while enhancing focus and information retention through engaging visual elements (Cholik & Umaroh, 2023). Additionally, animated presentations allow adolescents to understand health concepts more contextually and in ways that relate to their daily experiences (Melati et al., 2023). Therefore, the use of animated videos offers a more adaptive and appealing educational strategy, particularly for health learning within the school setting.

Findings from the preliminary study further emphasized the need for educational interventions among adolescent girls. Interviews conducted on March 11, 2025, with 10 students at SMAN 1 Cisarua revealed that nine of them lacked sufficient understanding of anemia. This observation was reinforced by the school's Student Affairs Vice Principal, who stated that most students had limited knowledge regarding the importance of iron intake and had never received education on anemia, either from local health centers or through school programs. The lack of exposure to accurate health information highlights a gap in health literacy that requires prompt attention, particularly given that anemia remains one of the most prevalent nutritional issues among Indonesian adolescents (Hermalasari et al., 2023).

Given these conditions, the use of digital educational media such as animated videos becomes a relevant alternative strategy to enhance adolescents' understanding of anemia. This medium offers advantages in delivering information that is engaging, easily accessible, and aligned with the learning preferences of the digital generation. When health information is presented visually and interactively, adolescents are more likely to understand, retain, and apply the knowledge in their daily lives (Cholik & Umaroh, 2023; Melati et al., 2023).Therefore, this study was conducted to evaluate the effect of digital education through animated videos on improving anemia-related knowledge among adolescent girls, while contributing to innovations in school-based health education media.

2. RESEARCH METHODOLOGY

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design to examine changes in anemia-related knowledge before and after a digital educational intervention. This design allows researchers to measure the effect of an intervention by comparing pre-intervention and post-intervention outcomes within the same group. The research object of this study was knowledge related to anemia among adolescent girls, which aligns with the study focus on health education and digital learning media (Arib et al., 2024).

The study was conducted at SMAN 1 Cisarua, Bogor Regency, Indonesia, a senior high school where no structured anemia education program had previously been implemented. The study population consisted of female students enrolled in Grade X, an adolescent age group that is physiologically vulnerable to anemia due to rapid growth and menstrual blood loss (Lestari, 2019). Classes X6, X7, and X9 were selected using purposive sampling, as preliminary observations and interviews indicated limited prior exposure to anemia-related education among students in these classes. Purposive sampling was considered appropriate because participants were selected based on specific characteristics relevant to the research objectives rather than representativeness of the general population (Arib et al., 2024).

The minimum sample size was estimated using the Slovin formula to ensure an adequate number of respondents for statistical analysis. Based on this calculation and participant availability, a total of 52 adolescent girls were included in the study. Data collection was conducted from April 28 to May 9, 2025, following administrative approval and informed consent procedures. Anemia knowledge was measured using a structured questionnaire adapted from Lestari (2019), consisting of 10 multiple-choice items addressing the definition, causes, symptoms, consequences, and prevention of anemia. Each correct answer was scored as one point, while incorrect answers were scored as zero. The

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instrument had previously undergone validity testing using Product Moment correlation and demonstrated acceptable reliability, with a Cronbach's alpha value of 0.763, indicating good internal consistency (Lestari, 2019).

The educational intervention consisted of a validated animated video on anemia, which served as the primary digital learning medium in this study. The video presented information on anemia in a visual and contextual manner, enabling adolescents to better understand health concepts (Cholik & Umaroh, 2023; Melati et al., 2023). Participants completed the pre-test prior to viewing the video and the post-test immediately after the intervention using the same questionnaire to ensure consistency of measurement. Prior to hypothesis testing, data were examined using the Kolmogorov–Smirnov normality test. Since the data were normally distributed, differences between pre-test and post-test knowledge scores were analyzed using a paired sample t-test, with a significance level set at $p < 0.05$. This analytical approach is appropriate for comparing mean differences between two related measurements within the same group (Arib et al., 2024). All stages of the research process adhered to ethical principles, including informed consent, anonymity, confidentiality, justice, and the principles of beneficence and non-maleficence (Arini et al., 2021; Caryanto & Awaludin, 2024; Feriadi et al., 2020).

3. RESULTS AND DISCUSSION

The univariate analysis in this study aimed to describe the basic characteristics of the respondents, including age, class level, and knowledge level before and after the educational intervention. Data obtained from 52 adolescent girls at SMAN 1 Cisarua showed variation in both age and class distribution, yet all respondents fell within the adolescent age range relevant to the study context.

Table 1. Respondents' Age Characteristics

Age	F	%
15	7	13.5
16	34	65.4
17	11	21.1
Total	52	100

Table 1 presents the age distribution, indicating that the majority were 16 years old (65.4%), followed by respondents aged 17 years (21.1%) and 15 years (13.5%). This confirms that most participants were in middle adolescence, a developmental period highly susceptible to anemia.

Table 2. Frequency Distribution of Class Levels

Class	F	%
X.6	17	32,7
X.7	17	32,7
X.9	18	34,6
Total	52	100

Meanwhile, Table 2 displays the distribution of respondents across class levels, showing that students were drawn from classes X.6, X.7, and X.9. Each class contributed a similar proportion of respondents, with X.6 and X.7 each representing 32.7% and X.9 accounting for 34.6%. This balanced distribution minimizes potential class-based bias within the sample. Knowledge levels before and after the educational intervention were analyzed univariately to describe changes in learning outcomes.

Table 3. Pre-Test Knowledge

Knowledge	F	%
Good	6	11,5
Moderate	42	80,8
Poor	4	7,7
Total	52	100.0

Table 3 presents the pre-test distribution, showing that 80.8% of respondents had "moderate" knowledge, 11.5% had "good" knowledge, and 7.7% demonstrated "poor" knowledge. This indicates that prior to the animated video intervention, most participants did not possess an optimal understanding of anemia.

Table 4. Post-Test Knowledge

Knowledge	F	%
Good	46	88,7
Moderate	4	7,7
Poor	2	3,8
Total	52	100

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Following the intervention, results in Table 4 show a substantial improvement: 88.7% of respondents attained a "good" knowledge level, 7.7% remained in the "moderate" category, and only 3.8% were categorized as having "poor" knowledge. This comparison clearly illustrates meaningful and positive changes in knowledge after the digital education was delivered.

The bivariate analysis aimed to determine the effect of digital education through animated videos on the anemia knowledge levels of adolescent girls at SMAN 1 Cisarua. Prior to conducting the Paired Sample T-Test, the Kolmogorov– Smirnov normality test was performed to ensure that both the pre-test and post-test knowledge scores were normally distributed. The test results confirmed that the datasets met the assumption of normality, allowing the use of parametric analysis. With this requirement satisfied, the analysis proceeded to assess whether a statistically significant difference existed between knowledge scores before and after the digital educational intervention.

Table 5. The Influence of Digital Education on Knowledge

Variabel	N	Before		After		Mean Difference	P Value
		mean	SD	Mean	SD		
Knowledge	52	65,19	3,326	76,58	3,577	2,353	0,000

Paired Sample T-Test results presented in Table 5 show a p-value of 0.000 ($p < 0.05$), indicating a statistically significant difference between pre-test and post-test knowledge scores. This result demonstrates that the digital educational intervention successfully improved respondents' knowledge. With the p-value falling below 0.05 and the confidence level set at 95%, the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted. Thus, the study concludes that digital education delivered through animated videos has a significant effect on enhancing anemia knowledge among adolescent girls at SMAN 1 Cisarua, aligning with the core objectives of the research.

Findings of this study indicate that most respondents were 16 years old, accounting for 65.4% (34 individuals), followed by those aged 17 years at 21.1% (11 individuals). All respondents who received digital education through the animated video were adolescent girls within the age range of 16 to 17 years. Knowledge improvement occurred across all age groups; however, respondents aged 16 and 17 demonstrated the highest average increase in post-intervention scores. This trend aligns with Piaget's cognitive development theory, which states that adolescents around the age of 16 typically enter the formal operational stage, characterized by abstract, logical, and systematic thinking. These cognitive abilities enhance their capacity to comprehend visual media such as animated videos and process educational content more effectively (Utaminingsih et al., 2024).

Overall, the findings show that most respondents were at an age considered cognitively ideal for receiving educational material. Nevertheless, being at the appropriate developmental stage did not automatically translate into high baseline knowledge, as most respondents were categorized as having "moderate" knowledge during the pre-test. This supports literature suggesting that increasing age is associated with maturation of physical and psychological functions, contributing to more complex thought processes (Ariana & Fajar, 2024). Age is also commonly used as an indicator of physical, mental, and social development (Febianti & Kusdinar, 2020), thereby influencing one's ability to understand and respond to health education. However, the limited initial knowledge observed in this study highlights that age alone is insufficient exposure to information, prior educational experience, and environmental influences remain crucial in shaping adolescents' knowledge.

3.1 Class-Level Characteristics

Based on the study findings, respondents were grouped into three class levels: X.6, X.7, and X.9. The analysis revealed that all classes experienced an increase in knowledge scores after receiving digital education through animated videos. Class X.7 showed the most significant improvement compared to the others, which may be influenced by factors such as student participation while viewing the video, enthusiasm toward innovative learning methods, and variations in baseline cognitive abilities across classes. Despite differences in the magnitude of improvement among classes, the results demonstrate that animated video based educational media positively impact all class levels involved in the study.

The effectiveness of digital educational media can be further explained through cognitive ability theory, which states that an individual's comprehension of information is influenced by their ability to process and interpret the material received (Muhammad & J., 2021). Furthermore, educational level contributes to one's capacity to understand information, as individuals with higher educational exposure tend to have better access and cognitive readiness to process educational content. Nevertheless, findings from this study indicate that despite classlevel differences, all respondents showed improved knowledge, suggesting that animated video learning is effective regardless of academic grouping. These findings highlight the adaptability and inclusiveness of animated educational media in reaching adolescents with diverse academic backgrounds.

Frequency distribution results show that prior to receiving the educational intervention, most respondents had a "moderate" level of knowledge at 80.8%, followed by "good" knowledge at 11.5% and "poor" knowledge at 7.7%. This indicates that the majority of adolescent girls lacked adequate understanding of anemia before the intervention was administered. The limited knowledge observed in the pre-test phase may be attributed to restricted access to health information and minimal exposure to educational materials concerning anemia. This finding aligns with (Savolainen, 2019), who states that knowledge is formed through sensory processes based on direct or indirect experiences; thus, limited exposure to relevant information leads to suboptimal knowledge formation.

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3.2 Post-Intervention Knowledge Level

Based on the findings from SMAN 1 Cisarua, respondents demonstrated a notable increase in knowledge after receiving education through animated videos. The post-test frequency distribution showed that 88.5% of respondents achieved a "good" level of knowledge, 7.7% were in the "moderate" category, and only 3.8% were classified as having "poor" knowledge. This improvement indicates that health education delivered through animated videos positively enhances adolescents' understanding of anemia. The educational media used in this study proved effective because it presented information visually, engagingly, and in a manner that was easily understood by adolescents. This aligns with the definition of health education as a systematic effort to equip individuals with information, knowledge, and skills that enable them to maintain or improve their health and adopt healthier behaviors (Sari et al., 2024).

The effectiveness of animated video media in improving knowledge is further supported by previous studies. Research by (Hanif, 2020) found that educational interventions improved adolescent girls' knowledge about anemia, as reflected by increased pre-test and posttest scores. Likewise, (Sari et al., 2024) stated that health education is considered successful when it results in increased knowledge, awareness, and the ability of individuals to participate actively in maintaining their health. In this study, most respondents were able to correctly answer statements regarding the definition, signs and symptoms, causes, and consequences of anemia after receiving the educational intervention. This finding is consistent with the study by (Andriyani et al., 2025), which concluded that health education significantly enhances adolescent girls' knowledge about anemia. Thus, animated video media effectively simplifies complex concepts, making them more accessible and memorable for adolescents.

3.3 Effect of Health Education on Knowledge

Following the digital educational intervention using animated videos, a significant increase in respondents' knowledge scores was observed. The Kolmogorov–Smirnov normality test indicated that both pre-test (0.063) and post-test (0.097) values exceeded the significance threshold of 0.05, confirming normal data distribution and supporting the use of parametric testing. The subsequent Paired Sample T-Test produced a p-value of 0.000 ($p < 0.05$), indicating a statistically significant difference between knowledge levels before and after the intervention. Thus, the alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected, confirming that digital education delivered through animated videos significantly improved anemia-related knowledge among adolescent girls at SMAN 1 Cisarua.

The primary objective of this study was to evaluate the extent to which animated video–based education enhanced adolescents' understanding of anemia. Pretest knowledge distribution revealed that 80.8% of respondents were in the "moderate" category, 11.5% in the "good" category, and 7.7% in the "poor" category, reflecting limited baseline understanding. After the intervention, the proportion of respondents in the "good" category increased dramatically to 88.5%, while the "moderate" category decreased to 7.7% and the "poor" category to 3.8%. These findings align with cognitive learning theories, which argue that audiovisual media improve attention, concentration, and knowledge retention. This result is also consistent with studies by (Housten et al., 2020) and (Dianti et al., 2021), which found that audiovisual media, including animated videos, significantly enhance comprehension and retention of health information

3.4 Characteristics of Respondents by Grade Level

The respondents in this study were distributed across three class groups X6, X7, and X9 and all groups demonstrated an increase in knowledge scores after receiving digital education through animated video media. Among the three, Class X7 showed the most notable improvement, which may be associated with varying levels of engagement, learning motivation, and the responsiveness of students toward innovative educational media. Differences in the magnitude of improvement across classes also suggest that the uptake of health education can be influenced by classroom learning dynamics and the heterogeneity of baseline cognitive readiness. These variations do not diminish the overall effectiveness of the intervention but instead underline the adaptable nature of animated video media across different academic groups.

Educational level is known to affect an individual's ability to receive, interpret, and utilize health information. Students in higher or more academically oriented classes often possess stronger cognitive processing skills, making it easier for them to internalize health messages delivered through audiovisual media. Conversely, students in groups with lower academic exposure may face challenges in processing new concepts, thus requiring more reinforcement to achieve similar learning outcomes. These findings align with educational theory suggesting that cognitive abilities shape one's capacity to understand health information and apply it within the context of self-care practices. The results of this study reaffirm previous claims that digital educational tools, particularly animated videos, remain effective across differences in academic levels, providing equitable opportunities for knowledge enhancement among adolescents.

The findings of this study show that a large proportion of respondents demonstrated only a moderate level of knowledge regarding anemia prior to the educational intervention, with 80.8% categorized as "moderate," 11.5% as "good," and 7.7% as "poor." This pattern reflects a limited baseline understanding among adolescent girls, suggesting that prior exposure to accurate and structured information on anemia was minimal. Limited access to reliable health information either from school programs, health services, or digital resources likely contributed to this condition. This is consistent with the concept that knowledge emerges from sensory processes shaped by both direct and indirect

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experiences; when exposure to health information is insufficient, the formation of strong conceptual understanding becomes impeded. The pre-intervention distribution further highlights that despite being within an age range associated with enhanced cognitive capacity, adolescents may still lack fundamental knowledge if educational inputs are not provided regularly.

Environmental influences and individual experiences also play a crucial role in shaping the pre-existing knowledge levels observed in this study. Adolescents who reside in environments with limited health communication or inadequate parental and institutional support for health literacy are more likely to exhibit lower levels of understanding. Previous literature emphasizes that supportive environments can accelerate the acquisition of knowledge, while prior experiences contribute to a stronger cognitive foundation for interpreting new information. In this study, the absence of school-based anemia education and the lack of prior involvement from healthcare providers likely contributed to low baseline knowledge scores. Thus, the pretest results not only describe the respondents' initial state but also reinforce the need for systematic and accessible health education efforts to reduce knowledge gaps among adolescents.

The effectiveness of animated educational media is further supported by previous research, which consistently indicates that audiovisual interventions significantly enhance the comprehension and retention of health-related information. Studies by (Andriyani et al., 2025) and (Sari et al., 2024) reinforce that structured health education can elevate knowledge, awareness, and readiness for behavioral change among adolescents. In this study, respondents demonstrated improved ability to correctly identify the definition, symptoms, causes, and potential consequences of anemia after the intervention. These results align with findings by (Andriyani et al., 2025), who concluded that health education contributes meaningfully to adolescents' understanding of anemia. The observed improvement underscores the value of animated video media as a pedagogical tool that effectively bridges knowledge gaps and supports the development of informed health behaviors among young people.

3.5 Limitations of Study

This study has several limitations that should be considered when interpreting the findings. One limitation is the absence of long-term follow-up assessments to determine whether the observed increase in knowledge is retained over time after the intervention. Without extended evaluation, the study cannot confirm the lasting effect of digital education through animated videos on participants' knowledge retention. Additionally, the study focused solely on the cognitive outcome of knowledge, without examining potential changes in attitudes or behaviors that may result from the intervention. Behavioral change is a key indicator of the overall effectiveness of health education, and its exclusion limits the comprehensiveness of the study's evaluation.

3.6 Implications and Relevance

The findings of this study demonstrate that digital education through animated videos significantly improves adolescents' knowledge about anemia. This indicates that visual-interactive educational approaches are highly relevant for adolescent audiences, who naturally gravitate toward digital media. The implications of this research are substantial for educational institutions and healthcare providers, particularly in designing more effective and accessible health promotion strategies for students. The use of digital educational media has the potential to enhance health literacy and support sustained anemia prevention efforts within school settings.

4. CONCLUSION

Based on the findings of this study conducted at SMAN 1 Cisarua, digital education delivered through animated videos was shown to have a significant effect on improving adolescent girls' knowledge about anemia. Prior to the intervention, most respondents demonstrated only a moderate level of knowledge; however, following the educational intervention, a substantial improvement was observed. This improvement was reflected in a statistically significant increase in mean knowledge scores after the intervention (mean difference = 11.39 points; $p < 0.05$), indicating that the animated video effectively enhanced participants' understanding of anemia. These findings suggest that animated video–based educational media are not only engaging for adolescents but also effective in delivering health information clearly and comprehensively. As a practical implication, this educational video may be integrated into school-based health programs, such as the School Health Unit (UKS), to support anemia prevention efforts among adolescent girls. Future research is recommended to evaluate the long-term retention of knowledge and to examine whether this digital educational approach can influence health-related behaviors, such as adherence to iron supplementation and healthy dietary practices.

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