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Effectiveness of a Digital-Based Reproductive Health Education in Improving Literacy and Healthy Behavior among Indonesian Adolescents

A Mixed Methods Study

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ABSTRACT

Low reproductive health literacy and healthy behavior among Indonesian adolescents remains a major challenge in the digital era, especially amid the widespread circulation of invalid information. This study evaluates the effectiveness of a digital-based reproductive health education model in improving adolescents' literacy and healthy behavior, while also exploring students' needs, barriers, and expectations. A sequential explanatory design was used across two phases. Phase I used a quasi-experimental approach involving 100 junior and senior high school students in Bandung (50 intervention; 50 control). Literacy and behavior were measured before, after, and three months post-intervention using valid and reliable instruments (CVI 0.87; α>0.8). Phase II used focus group discussions with 8 adolescents and interviews with 8 stakeholders, which were analyzed thematically. Results showed a significant increase in reproductive health literacy in the intervention group (52.3±12.1 to 78.9±9.8; p<0.001) and in healthy behavior (+21.4%; p=0.003), with a large clinical effect (Cohen's d=1.15) that was sustained for three months. Perceived benefits, peer support, and curriculum integration were key success factors. Qualitative findings highlighted the need for relevant content, interactive features, ease of access, privacy protection, and online counseling services, while limited digital access and infrastructure remained barriers. In conclusion, digital-based reproductive health education is effective and well received by adolescents, and its national implementation requires curriculum integration, equitable digital access, support services, and multisectoral collaboration.

Keywords
Adolescent Literacy
Digital Education
Educational Innovation
Healthy Behavior
Reproductive Health

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Introduction

Adolescent reproductive health is a critical issue in Indonesia. Recent data show that 5.6% of female adolescents and 3.5% of male adolescents have engaged in premarital sexual intercourse, carrying a high risk of unintended pregnancy and sexually transmitted infections. The rate of early marriage remained at 11.2% in 2020 [1]. Active reproductive health behavior is influenced by various factors, including negative attitudes toward reproductive health and limited access to accurate information [2]. The digital environment can affect adolescents' psychological well-being, which in turn affects their engagement with reproductive health information [3].

In the digital era, Indonesian adolescents face major challenges in accessing and verifying reproductive health information online, with 67% using the internet for this purpose yet only 23% able to confirm the accuracy of that information [4]. This situation is further exacerbated by widespread misinformation and the lack of comprehensive sexual and reproductive health (SRH) education, as shown by research indicating that negative attitudes toward reproductive health and limited access to trustworthy information contribute to risky behavior among adolescents [5]. Widespread misinformation can lead to negative health impacts, as many adolescents do not yet have the skills to critically evaluate online content [6].

Digital-based reproductive health education approaches have shown promising potential in improving adolescents' knowledge and healthy behavior [7]. A recent systematic review revealed that mobile-based reproductive health interventions increased adolescent knowledge by 30–45% and healthy behavior by 15–25% [8]. This is consistent with findings from various studies showing that educational interventions, especially those leveraging digital platforms, effectively increase knowledge of issues such as premenstrual syndrome and fertility [9]. In addition, the use of digital health technology has been linked to positive changes in adolescents' health behavior and mental health, suggesting that these tools can play an important role in promoting healthy lifestyles in the post-COVID-19 era [10]. Overall, these findings underscore the importance of leveraging digital platforms for reproductive health education among adolescents.

Recent research highlights the substantial potential of digital-based interventions in influencing adolescent health behavior, particularly in developing countries such as Indonesia [11]. The effectiveness of these interventions is closely tied to their contextualization within

the sociocultural framework of the target population. For example, the implementation of comprehensive sexuality education (CSE) programs in Indonesia shows that aligning educational content with local policies and community values is essential for gaining support from stakeholders, including government officials and school principals [12]. Furthermore, research shows that adolescents prefer information delivered through various digital media, underscoring the need for a multifaceted educational approach [13]. Therefore, developing a digital reproductive health education model aligned with the cultural context of Indonesian adolescents is essential for improving their sexual and reproductive health knowledge and behavior [4].

Nevertheless, the implementation of digital-based interventions for adolescent reproductive health in Indonesia still faces various challenges [7]. Research has identified several major barriers, including gaps in technology access, variation in digital literacy levels relative to existing health service systems, and a lack of long-term evaluation of the impact of these interventions on adolescents' reproductive health behavior [14]. Given the complexity of this problem, a comprehensive and multidisciplinary research approach is needed to develop an effective and sustainable educational model.

Materials and Methods

This study employed a two-phase sequential explanatory design, consisting of a quantitative phase using a quasi-experimental approach and a qualitative phase involving focus group discussions (FGDs) and in-depth interviews. All research procedures received ethical approval from the Health Research Ethics Committee of Universitas Aisyiyah Bandung (Approval No. 1170/KEP.01/UNISA-BANDUNG/III/2025). This study was conducted at several private junior and senior high schools in Bandung Regency from January to June 2025. The study population included adolescents aged 15–19 years enrolled in junior and senior high schools, as well as related stakeholders such as teachers, health workers, parents, and education policymakers in the study area.

In the Quantitative Phase (Phase 1), 100 adolescents were selected as the primary respondents, recruited from schools allocated through a two-stage cluster randomization procedure: ten junior/senior high schools in Bandung Regency that met the eligibility criteria were first randomly allocated at the school level to the intervention or control group (five schools per group) using a computer-generated random allocation sequence, thereby minimizing the risk of contamination between study conditions within the same school; adolescents at each designated school were then selected using stratified random sampling based on grade level. The intervention and control groups each consisted of 50 participants. It should be noted that this school-level cluster allocation, rather than individual-level randomization, is acknowledged as a methodological limitation related to intra-class

correlation (ICC) and the assumption of statistical independence in subsequent analyses (see the Limitations sub-section in the Discussion). In the Qualitative Phase (Phase 2), informants were determined purposively, involving 8 adolescents for Focus Group Discussions (FGDs) divided into 2 groups (each consisting of 4 participants from various educational backgrounds). For in-depth interviews, participants included 2 teachers, 1 health worker, 2 parents, and 1 policymaker. Inclusion and exclusion criteria followed standard adolescent health research protocols.

The intervention group received a structured, moderator-facilitated WhatsApp-based reproductive health education program delivered over 8 consecutive weeks, consisting of eight weekly sessions of approximately 30–45 minutes each. Each weekly session combined a scheduled broadcast containing short educational videos or infographics on a specific topic (puberty and reproductive anatomy, prevention of risky premarital sexual behavior, healthy dating relationships and prevention of early marriage, digital health literacy and misinformation, and help-seeking/referral pathways), an interactive quiz delivered through a linked online form to reinforce learning, and a moderated discussion segment within the WhatsApp group where participants could ask questions either openly or anonymously. Automated weekly reminder messages were sent to encourage program completion. Each intervention subgroup (approximately 25 adolescents per school) was facilitated by trained health cadres or lecturers from the research team, who monitored participant engagement and referred sensitive issues to a supervising health worker when necessary. This design is consistent with WhatsApp-based reproductive health education models that have been evaluated in comparable adolescent populations [15], [16], [17]. The control group received standard reproductive health education as provided under the applicable school curriculum, delivered in a single face-to-face lecture session using conventional printed educational materials, without WhatsApp-based reinforcement, interactive quizzes, or structured follow-up reminders.

To ensure the trustworthiness of the qualitative findings, the FGD and in-depth interview guides were developed based on the study's conceptual framework, reviewed by two qualitative methods experts outside the research team, and pilot-tested with two adolescents outside the main sample prior to data collection. Credibility was strengthened through member-checking (sharing preliminary theme summaries with a subset of participants for confirmation) and peer debriefing with the broader research team. Dependability and confirmability were supported by maintaining a detailed audit trail of coding decisions and analytic memos throughout the analysis process. All transcripts were independently coded by two researchers, with an inter-coder agreement (Cohen's kappa) of 0.81 before differences were reconciled through discussion and consensus [18].

In the first phase, data were collected using a structured questionnaire distributed to 100 adolescents aged 15–19 years from selected junior and senior high schools in Bandung Regency. The questionnaire consisted of several main components: (1) reproductive health literacy, (2) reproductive health behavior, (3) perceived benefits of digital education, and (4) environmental factors, particularly peer support. The instruments used to measure reproductive health literacy and behavior were developed based on nationally and internationally validated indicators and underwent content validity assessment by an expert panel, yielding a Content Validity Index (CVI) of 0.87 and an internal reliability (Cronbach's alpha) of 0.82, indicating excellent consistency and accuracy. The perceived benefits questionnaire, which covers perceived usefulness, ease of use, and relevance of digital content, was also validated with a CVI of 0.85 and reliability (α=0.81), making it suitable for use with adolescent respondents.

To clarify the psychometric properties of the instruments, the reproductive health literacy scale consisted of 20 items across three dimensions (biological/anatomical knowledge, risk-behavior knowledge, and health-service/help-seeking knowledge), scored on a 4-point scale (0 = incorrect to 3 = correct), yielding a raw score range of 0–60, which was subsequently converted to a 0–100 scale for ease of interpretation. The reproductive health behavior scale consisted of 15 items across two dimensions (protective behavior and risk-avoidance behavior), scored on a 4-point frequency scale (never to always; range 15–60). Content validity was established by a panel of five expert validators (two nursing/midwifery reproductive health academics, one public health specialist, one school counselor, and one adolescent health clinician) using the Aiken's V/content validity index (CVI) procedure, with item-level CVI values ranging from 0.83 to 1.00. The perceived benefits questionnaire (10 items, 4-point scale) and the peer support scale (8 items adapted from the Peer Support Scale, 4-point scale) followed the same expert panel validation procedure [19][20].

For environmental factors such as peer support, the instrument used was an adaptation of the Peer Support Scale, with a reliability value (Cronbach's alpha) of 0.80. Given the group-level allocation (school level), within-group pre-post changes were analyzed using a linear mixed-effects model (alternatively, generalized estimating equations/GEE) with a random intercept for school to account for intra-cluster correlation, followed by a paired t-test for descriptive comparison. Between-group differences in gain scores (posttest minus pretest, and follow-up minus pretest) were compared using analysis of covariance (ANCOVA), adjusting for baseline literacy score, age, sex, school type, prior reproductive health education history, and internet access. Multivariable logistic regression was used to estimate the adjusted odds ratio (AOR) for the binary healthy behavior outcome, and multiple linear regression was used to estimate standardized beta coefficients for the continuous engagement/usefulness outcome,

both adjusted for the same covariates and reported with 95% confidence intervals (CI). Pearson correlation was used to examine the relationship between platform usage frequency and literacy improvement. Qualitative data were analyzed using an inductive thematic approach following Braun and Clarke's six-phase framework.

Of the 120 adolescents assessed for eligibility across the ten participating schools, 20 adolescents were excluded (12 did not meet the inclusion criteria and were enrolled, with 50 allocated to the intervention group (5 schools) and 50 to the control group (5 schools) according to the cluster randomization procedure described above. All 100 allocated participants completed the posttest assessment, and 92 participants in each group completed the 3-month follow-up assessment; reasons for participants' loss at follow-up included school transfer (n=2) and are recorded and reported below.

Table 1. Baseline characteristics of intervention and control group participants.

Characteristic	Intervention (n=50)	Control (n=50)	p-value
Age, years, mean (SD)	16.4 (1.2)	16.2 (1.1)	0.387
Sex, female, n (%)	28 (56%)	26 (52%)	0.688
School level, junior high school, n (%)	20 (44%)	22 (44%)	0.686
Prior reproductive health education history, n (%)	18 (36%)	15 (30%)	0.523
Routine (daily) internet access, n (%)	44 (88%)	42 (84%)	0.564
Baseline reproductive health literacy score, mean (SD)	52.3 (12.1%)	53.0 (11.5%)	0.768

Baseline equivalence between the intervention and control groups was assessed prior to the intervention (Table 1). No statistically significant differences were found between groups on key baseline characteristics (all $p>0.05$), supporting the assumption that the observed posttest differences were attributable to the intervention rather than to pre-existing group differences.

Results and Discussion

A. Phase 1 (Quantitative Results)

Statistical analysis for the quantitative phase included paired t-tests, comparisons between the intervention and control groups, calculation of effect size (Cohen's d), and Pearson correlation tests to assess key success factors. Qualitative data were analyzed using an inductive thematic approach.

Table 2. Effectiveness of the digital-based reproductive health education model on adolescent literacy and healthy behavior

Variable	Intervention (n=50)	Control (n=50)	Change (%)	p-value	Effect Size (Cohen's d)
Reproductive Health Literacy (Pretest)	52.3 ± 12.1	53.0 ± 11.5	-	-	-
Reproductive Health Literacy (Posttest)	78.9 ± 9.8	55.2 ± 10.3	+51%	<0.001	1.15
Reproductive Health Literacy (3-Month Follow-up)	75.4 ± 10.2	54.7 ± 11.1	+44%	<0.01	-

Variable	Intervention (n=50)	Control (n=50)	Change (%)	p-value	Effect Size (Cohen's d)
Reproductive Healthy Behavior (%)	23.5	2.1	+21.4%	0.003	-
Platform Usage Frequency (r)	0.68	-	-	0.01	-
Perceived Usefulness (β)	0.72	-	-	<0.001	-
Peer Support (OR)	4.12	-	-	<0.001	-
Curriculum Integration (AOR)	3.78	-	-	<0.001	-
Effect of Anonymity on Engagement	-0.38	-	-	0.04	-

The intervention group showed an increase in mean reproductive health literacy score from 52.3 at pretest to 78.9 after the intervention. This improvement was also sustained at the three-month follow-up measurement (75.4). Reproductive healthy behavior increased by 23.5%, considerably higher than in the control group (2.1%). An effect size of Cohen's d = 1.15 indicates a substantial clinical impact of this intervention.

In addition to the within-group paired comparisons above, the between-group difference in literacy gain scores (posttest minus pretest) remained statistically significant after adjusting for baseline literacy, age, sex, school type, prior reproductive health education history, and internet access in an ANCOVA model accounting for school-level clustering ($F(1,93)=48.26$, $p<0.001$, adjusted mean difference=23.1, 95% CI [18.4–27.8]), indicating that the observed improvement was attributable to the intervention rather than to pre-existing imbalance between groups (see Table 1).

The frequency of digital platform use was significantly correlated with knowledge improvement ($r=0.68$; $p=0.01$). Other determinants of effectiveness, such as perceived usefulness, peer support, and school curriculum integration, were statistically shown to be key predictors of successful improvement in literacy and healthy behavior ($p<0.001$). There was a small negative effect of the anonymity factor on adolescent engagement, although this can be anticipated through appropriate feature design.

Effect estimates from the adjusted multivariable models confirmed key predictors of program effectiveness: peer support significantly increased the odds of healthy behavior (AOR=4.12, 95% CI: 1.85–9.18, $p<0.001$), as did school curriculum integration (AOR=3.78, 95% CI: 1.68–8.50, $p<0.001$). For the engagement outcome, perceived usefulness was significantly positively associated ($\beta=0.72$, 95% CI: 0.52–0.92, $p<0.001$), while anonymity showed a small but significant negative association ($\beta=-0.38$, 95% CI: −0.74 to −0.02, $p=0.04$). All estimates were adjusted for age, sex, school type, baseline literacy, prior reproductive health education history, and internet access. Overall, these findings support the recommendation that the digital education model is highly effective as an innovative strategy for improving reproductive health knowledge and healthy behavior among Indonesian adolescents.

B. Phase 2 (Qualitative Results)

The qualitative phase was conducted to deepen understanding of the experiences, needs, barriers, and expectations of adolescents and stakeholders following the implementation of the digital reproductive health education model. Data were collected from eight adolescents through Focus Group Discussions (FGDs) and from key informants (two teachers, one health worker, two parents, and one policymaker) through in-depth interviews. Thematic analysis yielded four main themes, as follows: Theme 1 (Need for Relevant and Accurate Information): Most participants emphasized the importance of information that is directly relevant to the real problems adolescents face and easy to understand. Adolescents preferred practical content, avoiding overly theoretical narratives. The issue of accuracy was also highlighted, given the widespread circulation of hoaxes and the difficulty of verifying sources on the internet. One example from the interview results: "We need information that is truly relevant to our problems, not something too theoretical." (FGD, female participant).

Theme 2 (Accessible and Interactive Digital Platform): Adolescents preferred health education applications that are easy to use, accessible via mobile devices, and equipped with interactive features such as quizzes, discussion forums, and even online consultation services. Social media platforms such as Instagram and TikTok were also seen as potential tools, as long as they are used for educational purposes. One example from the interview results: "Ideally the app should be easy to use, not complicated, and have quizzes too." (FGD, male participant).

Theme 3 (Implementation Barriers and Solutions): The main barriers identified were limited internet access, particularly in peripheral areas, along with concerns about privacy and the psychological impact of accessing sensitive content. Stakeholders suggested the need for cross-sector collaboration and technical support from schools and the government to expand access and ensure psychosocial safety. "The network here is sometimes problematic. Ideally the school would help facilitate this and provide counseling when needed." (Teacher, in-depth interview).

Theme 4 (Expectations for the Digital Education Model): Participants hoped that digital reproductive health education could be integrated into the school curriculum, maintain privacy, and be supervised by experts so that the content remains relevant, culturally sensitive, and accountable. One example from the interview results: "There must be oversight to keep it safe, and it should also be included in the curriculum." (Parent, in-depth interview)

Table 3. Summary of key qualitative findings from FGDs & in-depth interviews

Main Theme	Key Finding
Information Needs	Relevant, easy-to-understand content from trusted and verified sources
Platform	Easy-to-use application, quiz features, discussion forum & online consultation
Barriers & Solutions	Internet access problems, need for collaboration & online counseling
Expectations	Curriculum integration, privacy, expert supervision, cultural sensitivity

Findings from the qualitative phase of this study reinforce the quantitative results by providing an in-depth picture of the dynamics, context, and key success factors of digital-based reproductive health education among adolescents. To strengthen the intended integration of the sequential explanatory mixed-methods design, Table 4 presents a joint display linking each key quantitative finding with its corresponding qualitative theme, representative participant quotes, and an integrated interpretation, following established mixed-methods integration procedures [18], [21].

Table 4. Joint display of quantitative and qualitative findings

Quantitative Finding	Qualitative Theme	Representative Quote	Integrated Interpretation
Peer support as a significant predictor of engagement (AOR = 4.12, p<0.001)	Theme 2: Accessible and Interactive Digital Platform	"Ideally the app should be easy to use, not complicated, and have quizzes too." (FGD, male participant)	Adolescents highly value socially oriented interactive features (quizzes, discussion forums); peer-facilitated interaction likely reinforces program engagement and explains the strong quantitative association between peer support and effectiveness.
School curriculum integration as a significant predictor (AOR = 3.78, p<0.001)	Theme 4: Expectations for the Digital Education Model	"There must be oversight to keep it safe, and it should also be included in the curriculum." (Parent, in-depth interview)	Stakeholders' desire for formal curricular integration reinforces the quantitative finding that curriculum-integrated delivery strengthens the program's effectiveness and sustainability.
Small negative effect of anonymity on engagement (β = -0.38, p=0.04)	Theme 3: Implementation Barriers and Solutions	"The network here is sometimes problematic. Ideally the school would help facilitate this and provide counseling when needed." (Teacher, in-depth interview)	Although adolescents value privacy, fully anonymous interaction may reduce accountability and facilitator-led encouragement; participants' simultaneous requests for both supervision and counseling suggest that engagement would be better supported by a hybrid model that balances privacy with facilitated support (see the discussion of the anonymity paradox below).
Platform usage frequency correlated with literacy improvement (r=0.68, p=0.01)	Theme 1: Need for Relevant and Accurate Information	"We need information that is truly relevant to our problems, not something too theoretical." (FGD, female participant)	Content perceived as relevant and practical likely encourages more frequent platform use, which in turn is quantitatively associated with greater literacy improvement, illustrating the behavioral mechanism underlying the dose-response relationship.

First, the need for relevant and applicable information emerged as a key issue, consistent with recent literature emphasizing the importance of needs- and learner-preference-based approaches [22]. Adolescents wanted educational content that addresses everyday realities and problems, rather than purely theoretical material. This expectation forms an important basis for developing more effective digital education materials. The second about Platform

Preferences and the Significance of Interactive Features. Results show that educational platforms that are easy to use, mobile-friendly, and equipped with interactive features such as quizzes and discussion forums are highly preferred. Active engagement through these interactive features has been shown in previous research to improve knowledge retention and encourage tangible behavior change. Integrating online consultation features with experts also adds educational value for adolescents seeking anonymous and personal guidance [23].

For Access and Psychosocial Health (Implementation Barriers): The internet access gap remains a major barrier, particularly in rural areas. Several participants reported frequently experiencing difficulty accessing educational materials due to limited signal and data quota. In addition, there were concerns about psychological risk—particularly if adolescents are exposed to sensitive content without adequate supervision. It is important to strengthen both digital literacy and psychosocial readiness before such a model is scaled up massively [24][19]. One finding that warrants more critical interpretation is the small but statistically significant negative effect of anonymity on engagement ($\beta = -0.38$, $p = 0.04$), which at first appears to contradict adolescents' qualitative preference for privacy protection. This apparent paradox is more plausible than contradictory: fully anonymous interaction may reduce social accountability, reciprocal engagement, and the perceived personal relevance of facilitator feedback, all of which are known drivers of sustained engagement in digital health programs [25], [26]. Adolescents in the qualitative phase requested both privacy and active facilitation/counseling support (Theme 3), suggesting that anonymity and engagement are not always at odds but require deliberate design balancing—for example, pseudonymous (rather than fully anonymous) participation, opt-in identification for those wanting personal guidance, and clearly communicated confidentiality protections from the outset, consistent with telehealth design and digital confidentiality recommendations for adolescents [27]. Future program iterations should test such hybrid privacy models rather than treating anonymity as a uniformly protective design default.

The expectation of integrating digital health education into the school curriculum, along with expert content oversight, is consistent with national and international research recommendations regarding the safety and effectiveness of technology-based health programs. With a structured oversight system, educational materials will remain relevant, culturally appropriate, and provide a sense of psychosocial safety for participants [28].

Conclusion

This study shows that digital-based reproductive health education can significantly improve adolescents' literacy and healthy behavior. Meaningful improvements were observed in both knowledge and healthy practices following the intervention, with effects sustained up to three months post-education. Key success factors included perceived usefulness, peer

support, and integration of the program into the school curriculum. From a qualitative perspective, adolescents valued the ease of access, practicality, and interactive features of digital education, although barriers such as internet access and privacy needs remained major obstacles. The two-phase approach in this study provides a comprehensive picture and strategic input for the development of innovative adolescent health education in the digital era. This model can be recommended as a national strategy to improve reproductive health and strengthen digital literacy among the younger generation.

Sustainable implementation of the digital reproductive health education model requires direct adoption and integration into the school curriculum by education authorities and related institutions at the national level. The government, schools, and private-sector partners are expected to accelerate equitable access to digital infrastructure, particularly in rural and peripheral areas, to ensure that all adolescents have equal opportunities to obtain information and services. To maintain relevance, safety, and cultural sensitivity, strict content oversight by expert teams is needed, along with the development of online counseling services to complement education and protect adolescents' privacy and psychosocial health. The success of this program depends on cross-sector collaboration among schools, health offices, communities, families, and peers in creating a conducive learning ecosystem. In addition, further research is recommended with broader geographic coverage and variables, as well as adaptive digital feature innovations, so that adolescents' reproductive health needs can continue to be accommodated in line with the dynamic changes of the times.

In concrete policy terms, we recommend: (1) a phased pilot implementation of the WhatsApp-based model in five regencies/cities in West Java with contrasting urban-rural digital access profiles, coordinated by the provincial education and health offices, before scaling up province-wide; (2) formal integration of the program's content modules into the existing Biology and Physical/Health Education (PJOK) curricula at the junior and senior high school levels, rather than delivering it as a stand-alone extracurricular activity, to ensure institutional sustainability; (3) partnerships between local governments and internet service providers to provide free or subsidized data packages for accessing program content in low-income and rural areas; and (4) development of a low-bandwidth application version that can be used offline (e.g., downloadable video/text modules with periodic synchronization) to serve adolescents in areas with unstable internet connectivity, addressing the access barriers identified in the qualitative findings (Theme 3).

Conflict of Interest

The authors declare no conflict of interest.

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