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The effectiveness of a digital-based educational comic on adolescent knowledge of marriage age maturity at SMK rise, Cirebon regency

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ABSTRACT

Early marriage remains a significant issue affecting adolescents' reproductive health, education, and quality of life. This study aimed to develop and assess a digital educational comic on Marriage Age Maturity (Pendewasaan Usia Perkawinan/PUP) to improve adolescent knowledge at SMK RISE, Cirebon Regency. A Research and Development approach using a modified ADDIE model was combined with a quasi-experimental pretest-posttest control group design. 110 students participated, with 55 allocated to the digital comic group and 55 to the leaflet group through random allocation. Knowledge was measured using a 28-item true/false questionnaire (score range 0–28), with mean gain calculated as posttest mean minus pretest mean. Data were analyzed using the Wilcoxon Signed-Rank Test, Mann–Whitney U Test, and Rosenthal's *r* effect size. The digital comic achieved 85.5% feasibility. Mean gain was 0.96 in the comic group and 0.38 in the leaflet group. The comic group showed significant improvement ($p = 0.0016$; $r = 0.43$), while the leaflet group did not ($p = 0.2249$; $r = 0.16$). However, the between-group difference was not significant ($p = 0.410$; $r = 0.08$). Thus, the digital comic was highly feasible and showed preliminary evidence of increased knowledge, but was not statistically superior to the leaflet.

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INTRODUCTION

Marriage is a socially, legally, and religiously recognized union between two individuals, with marriage ceremonies varying according to ethnic traditions, religion, culture, and social class (Mubasyaroh, 2016). Early marriage refers to marriage involving individuals below the legally or socially recognized age of maturity and may pose substantial physical, psychological, educational, and social risks to adolescents. In particular, adolescent pregnancy is associated with increased risks of complications affecting both mothers and infants (Dini & Nurhelita, 2020; Mubasyaroh,

2016). Adolescence is a developmental period characterized by biological, emotional, social, and cognitive transitions from childhood toward adulthood (Rohaeni et al., 2024). Despite these developmental changes, early marriage remains a persistent phenomenon in Indonesia, occurring in both rural and urban settings. In Indonesia, the proportion of women aged 20–24 years who were married or living together before the age of 18 was 4.56% in 2025, while the corresponding proportion in West Java was 4.03% (Badan Pusat Statistik, 2026). This indicator specifically measures the proportion of women aged 20–24 years who entered their first marriage or cohabitation before the age of 18 and should therefore be interpreted according to this defined population and age threshold (Badan Pusat Statistik, 2026). Early marriage is also associated with adolescent pregnancy and can contribute to adverse maternal and child health outcomes, including risks related to inadequate fetal growth and stunting (Rahman et al., 2025).

Several factors contribute to early marriage, including low educational attainment, community and cultural norms, financial pressures, uncontrolled social interactions, and premarital sexual behavior that may result in adolescent pregnancy (Puspito & Nurbaya, 2023). Therefore, adolescents need adequate reproductive health knowledge to develop responsible attitudes and behaviors concerning reproductive processes and decision-making (Ernawati et al., 2022). Parents, who should ideally serve as the primary agents of reproductive health socialization, may nevertheless be reluctant to discuss reproductive organs and related issues because such topics are considered taboo (Fidora & Utami, 2022). Limited exposure to reliable reproductive health information may consequently encourage adolescents to obtain information from social media and other sources without sufficient guidance or contextual understanding (Dini et al., 2022). This situation highlights the need for attractive, accessible, and age-appropriate educational media that can effectively communicate information about reproductive health and Marriage Age Maturity (Pendewasaan Usia Perkawinan/PUP).

Marriage Age Maturity is an effort to encourage individuals to postpone first marriage until they have adequate physical, psychological, social, and economic preparation for establishing a quality family (Mardisentosa et al., 2021). Reproductive health education has been shown to improve adolescents' knowledge regarding marriage-age maturity, indicating the importance of accessible educational interventions for adolescents (Mardisentosa et al., 2021). Knowledge of Marriage Age Maturity can be considered an immediate educational outcome that may support adolescents in developing more informed attitudes, intentions, and decision-making concerning marriage. However, increased knowledge should not be interpreted as a direct change in the actual age at marriage, because changes in marriage behavior and age at marriage require longer-term observation. Accordingly, this study aimed to design and evaluate a digital comic-based educational medium concerning Marriage Age Maturity and to assess its effectiveness in improving adolescents' knowledge. The study employed a Research and Development (R&D) approach, which is intended to produce educational products and evaluate their effectiveness. However, previous educational interventions have more commonly focused on conventional counseling, printed materials, or other forms of digital media, while evidence concerning a digital comic specifically designed for Marriage Age Maturity remains limited. This direction is also consistent with broader national development priorities emphasizing human resource development, science and technology, education, health, gender equality, and the empowerment of women and youth.

Digital comics combine visual illustrations and textual information to present educational content in an engaging and accessible format. The integration of visual storytelling can facilitate audience engagement and help readers understand health-related information more effectively (Araya et al., 2021). Evidence from a literature review also indicates that comics can be an effective medium for increasing adolescents' health knowledge because information presented through illustrations and narratives may be easier to understand and remember (Septialti et al., 2022). In addition, comics have been recognized as a graphic communication option for conveying disease

and health information in educational contexts (Rakower & Hallyburton, 2022). The potential relationship between digital comic use and increased knowledge can be understood through the integration of visual, verbal, and narrative information. Presenting health messages through illustrations, characters, dialogues, and contextual situations may support attention, comprehension, and recall, thereby facilitating knowledge acquisition among adolescent learners (Araya et al., 2021; Septialti et al., 2022). In the context of Marriage Age Maturity, improved knowledge may subsequently contribute to more informed attitudes and decision-making regarding marriage readiness, although such an educational pathway does not in itself demonstrate a direct effect on the actual age at marriage.

Despite evidence supporting comics and digital media as health education tools, important research gaps remain. Previous studies have demonstrated the potential of comic-based education to improve adolescent health knowledge, but much of the available evidence concerns general health topics rather than Marriage Age Maturity specifically (Rakower & Hallyburton, 2022; Septialti et al., 2022). In addition, technology-based reproductive health interventions have often been evaluated as single interventions without direct comparison with conventional educational media. Therefore, the comparative effectiveness of a digital comic specifically developed for Marriage Age Maturity relative to leaflet-based education remains insufficiently established.

The novelty of the present study does not lie solely in the use of the Pixton platform. Rather, the innovation is reflected in the development of a context-specific educational product that translates Marriage Age Maturity content into adolescent-oriented storylines, characters, dialogues, and visual panels. The development process was based on needs identified through preliminary interviews with students and teachers and was followed by expert validation and adolescent user evaluation before effectiveness testing. Thus, the study combines systematic media development, content validation, user feasibility assessment, and comparative effectiveness evaluation within a single Marriage Age Maturity education intervention.

Based on this rationale, the present study hypothesized that adolescents receiving the digital educational comic would demonstrate a greater improvement in Marriage Age Maturity knowledge than adolescents receiving leaflet-based education (H1). The null hypothesis (H0) stated that there would be no statistically significant difference in knowledge improvement between the two groups. Accordingly, this study aimed to (1) develop a digital educational comic on Marriage Age Maturity for adolescents, (2) assess its feasibility based on expert and adolescent user evaluations, and (3) determine whether the digital educational comic produces a greater improvement in adolescents' Marriage Age Maturity knowledge than leaflet-based education.

RESEARCH METHOD

This study employed a Research and Development (R&D) approach focusing on the development and evaluation of an educational product. R&D is commonly used in educational research to develop instructional products through systematic stages of design, development, validation, field testing, revision, and evaluation (Gall et al., 2007). The product developed in this study was a digital educational comic on Marriage Age Maturity (Pendewasaan Usia Perkawinan/PUP). The development procedure adopted a modified ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation. ADDIE provides a systematic framework for developing instructional products by linking needs analysis, instructional design, product development, implementation, and evaluation (Branch, 2009; Crawford, 2004).

The study began with a preliminary study involving five teachers and five students at SMK RISE, Cirebon Regency, to identify information gaps and the educational needs of the target population. A SWOT analysis was subsequently conducted based on the information obtained from the interviews. The population consisted of all tenth- and eleventh-grade students at SMK RISE, Cirebon Regency, totaling 120 students. A total sampling technique was employed, whereby all members of the accessible population were included in the study. Of the 120 students, 10

participated in the small-group feasibility trial, while the remaining 110 students participated in the effectiveness evaluation. The 110 students were first grouped according to class and study program (X Pharmacy, X Nursing, XI Pharmacy, and XI Nursing) and were subsequently randomly allocated into an intervention group receiving the digital comic (n = 55) and a control group receiving a leaflet (n = 55).

The inclusion criteria were students in grades X and XI who were registered at SMK RISE, Cirebon Regency, were able to read and understand Indonesian, were willing to participate in the study, and had access to a smartphone for accessing the digital comic. Students were excluded if they were absent during data collection, did not complete the intervention, did not complete the posttest, withdrew from the study, or experienced technical problems that prevented access to the intervention materials. No participants dropped out during the study, and all 110 participants completed the pretest, intervention, and posttest.

The development process consisted of five stages. During the Analysis stage, the research team conducted a SWOT analysis based on interviews with students and teachers to identify educational needs, information gaps, strengths, weaknesses, opportunities, and potential challenges. During the Design stage, the research team conducted brainstorming activities involving the research team and midwifery students from STIKes Cirebon. The main educational needs were identified and the relevant topics were formulated into a preliminary storyboard and comic-panel draft concerning Marriage Age Maturity. This stage was conducted from July to August. The content and presentation of the comic were designed using adolescent-oriented storylines, characters, dialogues, and visual panels to communicate Marriage Age Maturity in a contextual and accessible format. During the Development stage, the digital comic draft was reviewed and validated by a language expert and a reproductive health expert. Expert validation is an important stage in the development of educational products because it provides an initial assessment of the suitability and quality of the developed material before field implementation (Gall et al., 2007).

The validation involved two expert validators. One validator was a lecturer in midwifery with competence in reproductive health and adolescent reproductive health, while the other was a lecturer in language with competence in educational media development. Both validators held a master's degree (S2) and the functional academic position of Lektor. The validation instrument employed a modified four-point Likert scale ranging from 1 to 4 to assess the feasibility of the developed comic. The use of Likert-type scales is well established for measuring responses to statements or evaluative items (Likert, 1932). The language validation instrument consisted of 20 assessment items covering readability, clarity of information, language use, dialogue, Indonesian language rules, cultural appropriateness, and language attractiveness. The reproductive health validation instrument consisted of 25 assessment items covering material suitability, accuracy of reproductive health information, Marriage Age Maturity content, risks of early marriage, educational benefits, and feasibility of use.

Each validation item was scored using a four-point Likert scale, with 4 = very good, 3 = good, 2 = fair, and 1 = poor. The feasibility percentage was calculated by dividing the obtained score by the maximum possible score and multiplying by 100. The feasibility categories were interpreted as follows: 81–100% = highly feasible, 61–80% = feasible, 41–60% = moderately feasible, 21–40% = less feasible, and ≤20% = not feasible.

During the Implementation stage, the revised digital comic was tested on a small group of 10 students. The digital comic was provided once, and participants were instructed to read it for 10 minutes. The comic was developed using the Pixton platform and accessed through a link distributed in the form of a barcode. Students read the digital comic independently using their own smartphones under the supervision of the researcher and teacher in the classroom. Before the intervention, the researcher provided brief instructions regarding the study procedure and how to access the comic. The researcher ensured that participants could access and complete the comic. No

additional explanation of the comic content was provided during the intervention to minimize potential bias in the knowledge assessment.

During the Evaluation stage, the effectiveness of the digital comic was assessed among 110 students at SMK RISE, Cirebon Regency. The participants were divided into two groups: an intervention group receiving the digital comic and a control group receiving a leaflet. The control group received the leaflet once and was instructed to read it for 10 minutes. The substantive educational content presented in the leaflet was equivalent to that presented in the digital comic.

The effectiveness evaluation employed a quasi-experimental pretest-posttest control group design. This design enables researchers to assess changes in outcomes before and after an intervention and to compare changes between an intervention group and a control group, making it suitable for evaluating educational innovations (Dugard & Todman, 1995). Knowledge regarding Marriage Age Maturity was measured before and after the intervention in both groups. The knowledge questionnaire consisted of 28 items and was developed based on the BKKBN Pocket Book on Marriage Age Maturity. Each correct answer was scored 1 and each incorrect answer was scored 0, resulting in a total score ranging from 0 to 28. The instrument had previously undergone validity and reliability testing in an earlier study published in 2020.

The Wilcoxon Signed-Rank Test was used to assess changes in knowledge within each group, while the Mann–Whitney U Test was used to compare knowledge improvement between the intervention and control groups. These nonparametric tests are appropriate for comparing paired observations and independent groups when parametric assumptions are not met (Weaver et al., 2017). The mean gain score was calculated as the difference between the mean posttest and mean pretest scores. The mean gain score was 0.96 in the digital comic group, calculated from the mean posttest score of 25.89 minus the mean pretest score of 24.93, whereas the mean gain score was 0.38 in the leaflet group, calculated from 25.40 minus 25.02. Effect size was calculated using Rosenthal's effect size (r) to complement the p-value and describe the magnitude of the observed effect. The level of statistical significance was set at $\alpha = 0.05$.

This study received ethical approval from the Health Research Ethics Committee of RSD Gunung Jati Cirebon City under ethical approval number No. 023/LAIKETIK/KEPKRSGJ/VIII/2026. The approved protocol was submitted by the principal investigator, Agi Yulia Ria Dini, on behalf of Sekolah Tinggi Ilmu Kesehatan (STIKes) Cirebon. The ethics committee declared the study ethically appropriate according to the seven WHO 2011 ethical standards, including social value, scientific validity, equitable assessment and benefits, risks, persuasion/exploitation, confidentiality and privacy, and informed consent. The ethical approval was valid from 26 August 2026 to 26 August 2027. Because the participants were adolescents, ethical considerations concerning informed consent, privacy, confidentiality, and protection of participants were particularly important and are consistent with international guidance for research involving adolescents and sexual and reproductive health (World Health Organization, 2011, 2018). Data collection was conducted in August 2026. All 110 participants who entered the effectiveness evaluation completed the study procedures, and no participant withdrew or was excluded from the final analysis.

RESULTS AND DISCUSSIONS

The development of the digital educational comic on Marriage Age Maturity (Pendewasaan Usia Perkawinan/PUP) was conducted using a modified ADDIE model consisting of Analysis, Design, Development, Implementation, and Evaluation. The analysis stage began with a preliminary needs assessment through interviews with five teachers and five students at SMK RISE, Cirebon Regency. The findings indicated that students had not previously received specific information or counseling regarding Marriage Age Maturity. The results of the SWOT analysis are presented in Table 1. The use of a systematic development process through analysis, design, development,

implementation, and evaluation is consistent with the ADDIE instructional design framework (Branch, 2009).

Table 1. SWOT Analysis of Digital Comic Development

SWOT Component	Findings
Strengths (S)	1. The school has Wi-Fi facilities, allowing students to access and reread the digital comic. 2. Students have smartphones that can be used to access the digital comic link.
Weaknesses (W)	1. Not all students have the same level of digital literacy. 2. There are no specific learning materials concerning Marriage Age Maturity in the existing subjects.
Opportunities (O)	1. High use of smartphones and digital media among adolescents. 2. Government programs aimed at preventing early marriage. 3. Limited availability of digital comic-based educational media concerning Marriage Age Maturity. 4. Potential use in school health programs, PIK-R activities, and health promotion. 5. Potential for further development into other reproductive health educational media.
Threats (T)	1. The prevalence of invalid reproductive health information on social media. 2. Competition with various digital entertainment contents that attract adolescents' attention. 3. Differences in technological access among students. 4. Low reading interest among some adolescents.

The SWOT analysis indicated that the school environment and students' access to smartphones provided favorable conditions for implementing a digital educational medium. However, differences in digital literacy and the absence of specific Marriage Age Maturity learning materials represented challenges that needed to be considered during product development. At the same time, the high use of digital media among adolescents and the availability of government programs aimed at preventing early marriage provided opportunities for implementing the product in adolescent health promotion activities. The needs assessment therefore provided a practical basis for developing a digital medium that could be accessed through students' existing smartphones and presented in a format appropriate for adolescents.

Following the needs analysis, the research team proceeded with the design and development of the digital comic. Brainstorming activities were conducted by the research team involving midwifery students from STIKes Cirebon. The main educational needs were identified and formulated into topics, storylines, characters, dialogues, and comic panels concerning Marriage Age Maturity. The product was developed using the Pixton platform. Rather than relying solely on the use of Pixton as the novelty, the digital comic was designed specifically for adolescents by integrating age-appropriate storylines, characters, dialogues, visual panels, and reproductive health content concerning Marriage Age Maturity. The narrative format was selected to present reproductive health information in a contextual manner that was relevant to adolescents' daily lives. Illustrations, colors, characters, and communicative dialogue were incorporated to support the presentation and comprehension of the educational messages, consistent with previous evidence that visual storytelling and comics can facilitate the delivery of health information (Araya et al., 2021; Rakower & Hallyburton, 2022; Septialti et al., 2022).

The developed comic was subsequently validated by a language expert and a reproductive health expert. The results of the language expert assessment are presented in Table 2.

Table 2. Results of Language Expert Validation

Language Assessment Component	Score	Maximum Score	Percentage (%)	Category
Suitability to the target audience's language ability	31	40	77.5	Feasible
Accuracy of language rules	14	20	70.0	Feasible
Use of language style	16	20	80.0	Feasible

Total	61	80	76.25	Feasible

Based on Table 2, the digital educational comic obtained a total score of 61 out of 80, corresponding to a feasibility percentage of 76.25%, and was categorized as feasible. The assessment indicates that the language used in the comic was generally appropriate for the target audience, understandable, and supportive of the delivery of educational messages, although several minor improvements were still required. This validation provided evidence of language feasibility, but it should be interpreted as evidence concerning the quality of the developed product rather than evidence of intervention effectiveness.

The reproductive health expert assessment is presented in Table 3.

Table 3. Results of Reproductive Health Expert Validation

Material Assessment Component	Score	Maximum Score	Percentage (%)	Category
Material suitability	17	20	85.0	Highly feasible
Accuracy of reproductive health material	35	40	87.5	Highly feasible
Material presentation	12	16	75.0	Feasible
Educational benefits	12	16	75.0	Feasible
Educational media feasibility	6	8	75.0	Feasible
Total	82	100	82.0	Highly feasible

As shown in Table 3, the reproductive health expert gave a total score of 82 out of 100, equivalent to 82%, and categorized the digital comic as highly feasible. The findings indicate that the material was consistent with reproductive health concepts, relevant to the objectives of Marriage Age Maturity education, and capable of providing appropriate information to adolescent users. The feasibility results are consistent with previous health education media development research showing that digital comic products can receive favorable expert assessments when the content and presentation are appropriately developed (Batiari et al., 2025). Thus, the validation findings support the suitability of the developed product, while effectiveness must be assessed separately through comparison with the control condition.

After revision based on expert feedback, the digital comic was tested in a small-group field trial involving 10 students. The results are presented in Table 4.

Table 4. Results of Small-Group Field Trial (n = 10)

Assessment Component	Mean Score	Percentage (%)	Category
Visual appeal	3.68	92.0	Highly feasible
Language and readability	3.80	95.0	Highly feasible
Material quality	3.22	80.5	Feasible
Educational benefits	3.38	84.5	Highly feasible
Ease of use (usability)	3.24	81.0	Feasible
Presentation	3.20	80.0	Feasible
Total	20.52	85.5	Highly feasible

Table 4 shows that the digital educational comic achieved an overall feasibility score of 85.5%, categorized as highly feasible. The highest score was obtained for language and readability (95%), followed by visual appeal (92%), educational benefits (84.5%), usability (81%), material quality (80.5%), and presentation (80%). These findings indicate that the digital comic was well received by the adolescent users in terms of appearance, language, material, educational benefits, ease of use, and presentation. The small-group field trial therefore provided formative evidence that the product was acceptable and usable for the target users before effectiveness testing, consistent with the role of user evaluation in instructional product development (Dousay & Branch, 2023). The overall feasibility score of 85.5% therefore supports the continuation of the product to the effectiveness evaluation after minor revisions.

The effectiveness evaluation was subsequently conducted among 110 students. The students were divided into an intervention group receiving the digital comic and a control group receiving a leaflet. The participants consisted of 55 students in the digital comic group and 55 students in the leaflet group. Participants were grouped according to class and study program before allocation, and all participants completed the pretest, intervention, and posttest. The distribution of participant characteristics is presented below.

Table 5. Characteristics of Respondents in the Effectiveness Evaluation (n = 110)

Characteristic	n	%
Age (years)		
14	4	3.6
15	34	30.9
16	48	43.6
17	21	19.1
18	3	2.7
Sex		
Female	102	92.7
Male	8	7.3
Grade and Study Program		
X Pharmacy	5	4.5
X Nursing	42	38.2
XI Pharmacy	10	9.1
XI Nursing	53	48.2

The participants were predominantly female (92.7%) and aged 16 years (43.6%). The largest proportion of participants came from XI Nursing (48.2%). These characteristics should be considered when interpreting the applicability of the findings beyond the study setting.

The mean gain scores and between-group statistical analysis are presented in Table 6.

Table 6. Pretest, Posttest, and Mean Gain Scores

Group	Mean Pretest	Mean Posttest	Mean Gain
Digital comic	24.93	25.89	0.96
Leaflet	25.02	25.40	0.38

The digital comic group showed an increase in mean knowledge score from 24.93 at pretest to 25.89 at posttest, corresponding to a mean gain of 0.96. The leaflet group increased from 25.02 to 25.40, corresponding to a mean gain of 0.38. Thus, the observed increase was numerically greater in the digital comic group.

Table 7. Results of Effectiveness Testing (n = 110)

Group	Mean Gain	p-value
Digital comic	0.96	0.410
Leaflet	0.38	–

The digital comic group demonstrated a higher mean gain score (0.96) than the leaflet group (0.38). However, the Mann–Whitney U test produced a p-value of 0.410 ($p > 0.05$), indicating that the difference in knowledge improvement between the digital comic and leaflet groups was not statistically significant. Therefore, the higher numerical gain observed in the digital comic group should not be interpreted as statistical evidence of superiority over the leaflet.

Further analysis was conducted using the Wilcoxon Signed-Rank Test and effect size analysis to examine within-group changes and the magnitude of the observed effects. The results are presented in Table 8.

Table 8. Effect Size Analysis

Analysis	p-value	Effect Size (r)
Intervention: Pretest–Posttest	0.0016	0.43
Control: Pretest–Posttest	0.2249	0.16
Intervention versus Control	0.410	0.08

The Wilcoxon Signed-Rank Test showed a statistically significant increase in knowledge within the digital comic group ($p = 0.0016$), whereas the leaflet group did not show a statistically significant improvement ($p = 0.2249$). The effect size in the digital comic group was $r = 0.43$, compared with $r = 0.16$ in the leaflet group. However, the effect size for the direct comparison between groups was only $r = 0.08$. Effect size is useful for interpreting the magnitude of an observed effect alongside statistical significance (Lakens, 2013). Accordingly, the significant within-group result for the digital comic does not establish superiority because the direct between-group comparison remained non-significant ($p = 0.410$; $r = 0.08$).

The findings demonstrate that the digital comic was successfully developed as an educational medium through the modified ADDIE model. The analysis stage identified a clear need for Marriage Age Maturity education among students at SMK RISE, particularly because students had not previously received specific counseling on the topic. The involvement of needs assessment, expert validation, and small-group evaluation provided a structured basis for developing the educational product, consistent with the systematic nature of instructional product development (Branch, 2009; Gall et al., 2007). This supports the importance of conducting a needs assessment before developing educational media so that the resulting product corresponds to the actual characteristics and needs of the intended users.

During the design stage, the researchers formulated the educational content based on the identified needs and translated it into a digital comic consisting of storylines, characters, dialogues, and visual panels. The use of narrative and visual elements was intended to make the content more contextual and accessible to adolescents. This approach is supported by previous literature indicating that comics can function as a health education medium by integrating visual and textual information and presenting health messages in an accessible narrative format (Rakower & Hallyburton, 2022; Septialti et al., 2022). This approach is particularly relevant for reproductive health education because the subject may involve sensitive information that can be difficult to communicate through conventional text-based approaches.

The development stage demonstrated that the product achieved favorable expert assessments. The language expert validation resulted in a feasibility score of 76.25%, while the reproductive health expert validation produced a score of 82%. These results indicate that the digital comic was considered appropriate in terms of language, content, and educational relevance. The findings are also consistent with previous research demonstrating the feasibility and potential of digital comic-based educational media (Batiari et al., 2025).

The small-group field trial further strengthened these findings. The overall feasibility score of 85.5% indicated that the digital comic was highly feasible from the perspective of its adolescent users. The high scores for visual appeal and language readability suggest that the digital format successfully addressed important characteristics of adolescent learners. Dousay & Branch (2023) emphasize the importance of evaluating instructional products with users during development to determine their usability and suitability before wider implementation. In the present study, the field trial therefore served as an important formative evaluation stage before the effectiveness test. Nevertheless, these feasibility results should be interpreted separately from the effectiveness results because user acceptance does not demonstrate that one educational medium produces greater knowledge improvement than another.

The effectiveness findings require careful interpretation. The digital comic group experienced a greater mean increase in knowledge than the leaflet group, with mean gain scores of 0.96 and 0.38, respectively. Nevertheless, the Mann–Whitney U test yielded $p = 0.410$, indicating

that the observed difference between groups was not statistically significant. This means that the study cannot conclude that the digital comic was statistically superior to the leaflet in producing knowledge improvement. Although the within-group analysis showed a statistically significant improvement in the digital comic group ($p = 0.0016$), the corresponding between-group analysis did not show a significant difference. Therefore, the within-group finding should be considered evidence of improvement within the comic group rather than evidence of comparative superiority.

The absence of a statistically significant between-group difference may be related to several factors. One possible explanation is that baseline knowledge among participants was already relatively high, limiting the possible amount of improvement after the intervention and potentially producing a ceiling effect. This explanation should be interpreted cautiously because the present study did not directly test for a ceiling effect**.** In addition, both groups received information concerning the same subject matter, meaning that the leaflet also provided participants with relevant educational content. Consequently, both media had the potential to contribute to knowledge improvement, reducing the likelihood of detecting a statistically significant difference between groups.

Although the between-group comparison was not significant, the higher mean gain and larger within-group effect size in the digital comic group provide a descriptive indication of greater observed improvement rather than evidence of statistical superiority. The effect size of 0.43 in the intervention group was larger than 0.16 in the leaflet group. However, the direct comparison between groups produced an effect size of only 0.08, reinforcing the interpretation that the difference between the two educational approaches was limited.

The relatively stronger observed improvement in the digital comic group may be associated with its combination of visual and textual communication. The integration of images, colors, characters, and dialogues can attract attention and encourage engagement, while the narrative structure may facilitate understanding of sensitive or complex health topics. Rakower & Hallyburton (2022) reported that comics can function as a graphic medium for communicating health information and can support the presentation of complex or sensitive subjects through the combination of text and visual elements.

These findings are also consistent with the literature on adolescent health education using comics. Septialti et al. (2022) found that comics can be used as a medium for increasing adolescent health knowledge because they combine simple language, attractive illustrations, and narrative elements. Similarly, Safitri et al. (2022) reported that e-comic media based on Digital Story Maker could improve health knowledge through an engaging visual format. However, the present study adds an important comparative finding: although the digital comic group showed a statistically significant within-group increase, its knowledge gain was not significantly different from that of the leaflet group. Thus, previous evidence supporting comics as health education media should not automatically be interpreted as evidence that comics are superior to other educational media.

The findings also have theoretical implications for the use of digital comics in adolescent health education. The combination of visual, textual, and narrative components may provide a suitable format for communicating reproductive health information, but the present data do not demonstrate that these features alone produce superior knowledge outcomes. The effectiveness of a medium may also depend on learners' baseline knowledge, the characteristics of the comparison medium, exposure duration, and the sensitivity of the measurement instrument.

Several limitations should therefore be considered. First, the study was conducted in a single vocational school, and most participants were female, which may limit the generalizability of the findings. Second, the intervention consisted of a single educational exposure, so the study did not assess whether the observed knowledge changes would be maintained over time. Third, both groups received educational content on the same topic, making the leaflet an active comparator rather than a no-intervention control. Finally, confidence intervals were not reported in the present analysis; therefore, the magnitude of uncertainty around the estimated effects should

not be inferred beyond the reported p-values and effect sizes. Future studies with larger and more diverse samples, repeated intervention sessions, longer follow-up periods, and more comprehensive statistical reporting are needed to further examine the comparative effectiveness of digital comics.

Overall, the digital educational comic developed in this study demonstrated strong feasibility based on expert validation and adolescent user evaluation. The product obtained a language feasibility score of 76.25%, a reproductive health content feasibility score of 82%, and a small-group feasibility score of 85.5%. The digital comic group also experienced a higher mean gain score and a statistically significant within-group improvement, accompanied by an effect size of 0.43. However, because the Mann–Whitney U test showed no statistically significant difference between the digital comic and leaflet groups ($p = 0.410$), the findings do not establish that the digital comic was superior to the leaflet. The digital comic should therefore be regarded as a feasible and promising alternative educational medium for Marriage Age Maturity education rather than as a statistically proven superior intervention. Its combination of visual storytelling, accessible language, and digital delivery nevertheless provides potential for supporting Marriage Age Maturity education among adolescents and for further application in school health promotion and reproductive health education.

CONCLUSION

The digital educational comic on Marriage Age Maturity was successfully developed using a modified ADDIE model and was considered feasible based on expert validation and small-group evaluation, with feasibility scores of 76.25%, 82%, and 85.5%, respectively. The digital comic group showed an increase in knowledge, with a mean gain score of 0.96 and a significant within-group improvement ($p = 0.0016$; $r = 0.43$). However, the difference in knowledge improvement between the digital comic and leaflet groups was not statistically significant ($p = 0.410$; $r = 0.08$), indicating that the present study does not provide sufficient evidence that digital comics are superior to leaflets. These findings provide preliminary evidence that digital comics are a feasible alternative medium for Marriage Age Maturity education, while further studies with larger and more diverse samples and longer follow-up are needed to examine their comparative effectiveness and longer-term educational outcomes.

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References

Araya, B., Pena, P., & Leiner, M. (2021). Developing a health education comic book: the advantages of learning the behaviours of a target audience. Journal of Visual Communication in Medicine, 44(3), 87–96. https://doi.org/10.1080/17453054.2021.1924639

Badan Pusat Statistik. (2026). Proporsi Perempuan Umur 20–24 Tahun yang Berstatus Kawin atau Berstatus Hidup Bersama Sebelum Umur 18 Tahun Menurut Provinsi (Persen), 2025. Badan Pusat Statistik. https://www.bps.go.id/id/statistics-table/2/MTM2MCMy/proporsi-perempuan-umur-20-24-tahun-yang-berstatus-kawin-atau-berstatus-hidup-bersama-sebelum-umur-18-tahun-menurut-provinsi–persen-.html

Batiari, N. M. P., Kurnianingsih, I. D. K. D. S., & Ariyanti, K. S. (2025). Development of Digital Comic Strip Media on Conventional and Electric Cigarette Control with the Addie Model. Journal of Public Health and Nursing, 1(1), 20–28. https://doi.org/10.64021/jphn.1.1.20-28.2025

Branch, R. M. (2009). Instructional Design: The ADDIE Approach (1st ed.). Springer. https://doi.org/10.1007/978-0-387-09506-6

Crawford, C. (2004). Non-linear instructional design model: Eternal, synergistic design and development. British Journal of Educational Technology, 35(4), 413–420. https://doi.org/10.1111/j.0007-1013.2004.00400.x

Dini, A. Y. R., Bakoil, M. B., Karo, M. B., Iskandar, F. N., Diana, A. N., A'yun, S. Q., Fatmawati, E., Isnaini, F., Dewi, R. S., & Lestari, Y. D. (2022). Konsep Asuhan Kesehatan Reproduksi untuk Mahasiswa Kebidanan. Rena Cipta Mandiri.

Dini, A. Y. R., & Nurhelita, V. F. (2020). Hubungan Pengetahuan Remaja Putri Tentang Pendewasaan Usia Perkawinan Terhadap Risiko Pernikahan Usia Dini. Jurnal Kesehatan, 11(1). https://doi.org/10.38165/jk.v11i1.197

Dousay, T. A., & Branch, R. M. (2023). Survey of Instructional Design Models (6th ed.). Brill. https://doi.org/10.1163/9789004533691

Dugard, P., & Todman, J. (1995). Analysis of pre-test-post-test control group designs in educational research. Educational Psychology, 15(2), 181–198. https://doi.org/10.1080/0144341950150207

Ernawati, H., Wijayanti, A. R., Mas'udah, A. F., & Setiawan, F. (2022). Pernikahan Dini – Culture Serta Dampaknya. CV. Amerta Media.

Fidora, I., & Utami, A. S. (2022). Pengaruh Pendidikan Kesehatan Reproduksi terhadap Tingkat Pengetahuan Remaja. Jurnal Keperawatan Abdurrab, 5(2). https://doi.org/10.36341/jka.v5i2.2221

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). Educational Research: An Introduction (8th ed.). Pearson/Allyn & Bacon.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. Frontiers in Psychology, 4, 863. https://doi.org/10.3389/fpsyg.2013.00863

Likert, R. (1932). A Technique for the Measurement of Attitudes (Number 140). Archives of Psychology, Columbia University.

Mardisentosa, B., Dahlan, J. A., Dharmayanti, N., Afriadi, B., Kusumastuti, N. A., Pratiwi, A., & Khaeriyah, S. (2021). Pengembangan Model Pendidikan Kesehatan Remaja dalam Pendewasaan Usia Perkawinan: Mengukur Batasan Usia Sisi Kesehatan dan Emosional untuk Berkeluarga. JKKP (Jurnal Kesejahteraan Keluarga Dan Pendidikan), 8(2), 120–130. https://doi.org/10.21009/JKKP.082.01

Mubasyaroh. (2016). Analisis Faktor Penyebab Pernikahan Dini dan Dampaknya bagi Pelakunya. YUDISIA: Jurnal Pemikiran Hukum Dan Hukum Islam, 7(2), 385–411. https://doi.org/10.21043/yudisia.v7i2.2161

Puspito, D. S., & Nurbaya, F. (2023). Faktor Penyebab Pernikahan Dini pada Remaja Putri dan Upaya Pencegahannya. PT Arr Rad Pratama.

Rahman, F., Erlyani, N., Wulandari, A., & Akbar, A. D. F. (2025). Membangun Kesiapan Remaja: Strategi Pendewasaan Usia Pernikahan. Uwais Inspirasi Indonesia.

Rakower, J., & Hallyburton, A. (2022). Disease Information Through Comics: A Graphic Option for Health Education. Journal of Medical Humanities, 43(3), 475–492. https://doi.org/10.1007/s10912-022-09730-9

Rohaeni, E., Dini, A. Y. R., Iis, Nisa, I. C., Mutiah, D., Kurniasih, D., & Berliana, E. (2024). Peran Gizi dalam Kesehatan Reproduksi pada Remaja. Health Care: Journal of Community Service, 2(2), 152–157. https://doi.org/10.62354/healthcare.v2i2.49

Safitri, D. E., Aprilia, N., & Novrika, B. (2022). Efektifitas Pengunaan E-Comic (Digital Story Maker) terhadap Pengetahuan dan Tindakan tentang Kesehatan Gigi dan Mulut pada Anak Kelas IV dan V. Jurnal Kesehatan Medika Saintika, 13(1), 283–288. https://doi.org/10.30633/jkms.v13i1.1355

Septialti, D., Shaluhiyah, Z., & Widjanarko, B. (2022). The Effectiveness of Using Comics in Efforts to Increase Adolescent Health Knowledge: A Literature Review. Jurnal Aisyah: Jurnal Ilmu Kesehatan, 7(S1), 273–280. https://doi.org/10.30604/jika.v7iS1.1134

Weaver, K. F., Morales, V. C., Dunn, S. L., Godde, K., & Weaver, P. F. (2017). Mann–Whitney U and Wilcoxon Signed-Rank. In An Introduction to Statistical Analysis in Research: With Applications in the Biological and Life Sciences. Wiley. https://doi.org/10.1002/9781119454205.ch7

World Health Organization. (2011). Standards and Operational Guidance for Ethics Review of Health-Related Research with Human Participants. World Health Organization.

World Health Organization. (2018). Guidance on Ethical Considerations in Planning and Reviewing Research Studies on Sexual and Reproductive Health in Adolescents. World Health Organization.