

Pregnancy Education Roadmap Tool and Maternal Health Literacy Among Pregnant Women

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ABSTRACT

Maternal health literacy (MHL) enables pregnant women to access, understand, appraise, and apply health information. This study compared MHL during pregnancy between women who received an interactive pregnancy education roadmap (SisMaps) and those who received routine antenatal education. A quasi-experimental posttest-only control group study was conducted among 64 pregnant women with low-risk singleton pregnancies (>13 to <37 weeks of gestation) recruited from five primary healthcare facilities in Banyuwangi, Indonesia. Participants were allocated non-randomly, by order of registration, to an intervention group (n=32) receiving a single SisMaps session or a control group (n=32). MHL was measured about two hours after the session using the Maternal Health Literacy Inventory in Pregnancy (MHELIP; score range 0–100). The total MHELIP score was higher in the intervention group (80.01±12.04) than in the control group (66.12±11.63) (mean difference 13.89, 95% CI 7.97–19.81; Cohen's d = 1.17; p<0.001). Scores were also higher in knowledge, information seeking, information appraisal, and decision-making (all p<0.009). Women who received SisMaps had higher MHL scores shortly after the session than those receiving routine education. SisMaps may be useful tool for midwives to support maternal health literacy in antenatal education.



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INTRODUCTION

Maternal Health Literacy (MHL) gives women the ability to obtain, comprehend, assess, and use health information, which directly influences pregnancy outcomes, delivery experiences, and postpartum care (Chandrakar et al., 2025). These abilities correspond to the four domains of the Maternal Health Literacy Inventory in Pregnancy (MHELIP): accessing or searching for information (information seeking), understanding it (knowledge), appraising it (information appraisal), and applying it in pregnancy-related decisions (decision-making and behavior). MHL therefore represents a broader set of competencies than knowledge alone (Taheri et al., 2020). Inadequate health literacy among pregnant and postpartum women has been reported across diverse contexts and measured using various instruments, including Nigeria (Bello et al., 2022), Laos (Phommachanh et al., 2021), Ethiopia (Jiregna et al., 2024), Turkey (Guler et al., 2021), Europe (Gaupsienė et al., 2023), Iran (Ghotbizadeh et al., 2023), and Indonesia (Irwan et al., 2024). Despite the wide availability of educational media, many pregnant women still find it difficult to access, understand, evaluate, and make use of the health information they receive.

Maternal health literacy (MHL) is influenced by various factors, both individual and environmental. Education, age,

occupation, and care provision during pregnancy are reported to be associated with MHL (Asadi et al., 2020). In addition to these factors, various studies also show that low MHL is related to mothers' limited understanding of various aspects of health during pregnancy (Meldgaard et al., 2022). Pregnant women with low MHL tend to have less knowledge about infant oral hygiene, nutrition, preeclampsia, and antenatal care compared to mothers with adequate MHL (Cho et al., 2007; Guler et al., 2021; Vilella et al., 2016; You et al., 2012).

Several other determinants that influence low health literacy include the capacity of health workers, the quality of the living environment, and the psychological condition of pregnant women (Ohnishi et al., 2005; Recto & Dimmitt Champion, 2018). Low MHL is also associated with an increased need for drug information, negative beliefs about drug use, and non-compliance with daily vitamin consumption and breastfeeding practices (Hämeen-Anttila et al., 2015; Lupattelli et al., 2014; Poorman et al., 2014; Wilson et al., 2012). In contrast, mothers with higher MHL show better health behaviors, such as receiving preconception counseling, undergoing routine health checks, using folic acid, and engaging in regular physical activity (Aslantekin et al., 2019; Lori et al., 2014). Adequate MHL also contributes to the management of chronic diseases such as diabetes, where pregnant women with limited health literacy are more likely

to experience poorly managed diabetes (Dayyani et al., 2019). MHL has a direct impact on health behaviors and pregnancy outcomes (Chandrakar et al., 2025).

Empowering low-income pregnant women, strengthening the role of midwives as frontline health service providers, and optimizing a health service system that is responsive to literacy needs are key elements in improving maternal health literacy (MHL) (Ningrum, Lusmilasari, Huriyati, Marthias, et al., 2024). In addition, empowering low-income pregnant women is a strategic component in improving MHL because this group often experiences multiple barriers, such as limited access to information, low levels of education, and limitations in health decision-making (Ningrum, Lusmilasari, Huriyati, & Hasanbasri, 2024). Interventions that focus on improving maternal capacity, whether through community-based education, the use of simple educational media, or support from health cadres, have been shown to improve mothers' ability to understand pregnancy information and make appropriate health decisions (Ningrum, Lusmilasari, Huriyati, Marthias, et al., 2024). The use of digital educational media is an effective strategy for improving maternal health literacy because it can bridge the gap in understanding (Mulyani et al., 2024).

However, although various educational media have been widely used, a number of limitations remain (Feldman et al., 2024; Karamolahi et al., 2021). Many educational media lack a systematic learning structure; information is presented in a fragmented manner, making it difficult for mothers to understand the complete flow of pregnancy knowledge, from preconception, antenatal, childbirth, to postpartum (Bharadwaj & Kaur, 2015; Whitworth et al., 2024). This condition indicates a research gap, namely the limited availability of educational media that integrate information across the continuum of pregnancy care into a single navigable, sequential, and interactive roadmap with a structured, gradual, and easy-to-follow learning flow according to the mother's needs.

The pregnancy education roadmap tool has the potential to be a solution because it can integrate information across the continuum of pregnancy care in a logical sequence within a single interactive medium, present it comprehensively yet simply, and adjust modules based on needs. We propose that specific features of SisMaps support the abilities that constitute MHL: its sequential structure may facilitate comprehension (knowledge), visual presentation may support information processing (information appraisal), interactive navigation may encourage independent information seeking (information seeking), and need-based modules may help women apply information in decisions (decision-making and behavior). These mechanisms are hypothesized and were not measured in this study. This study aimed to compare maternal health literacy (MHL) during pregnancy, that is, pregnancy-specific health literacy measured with the MHELIP, between pregnant women who received the pregnancy education roadmap tool (SisMaps) and those who received routine antenatal education.

METHODS

Study Setting and Design

This research employed a quasi-experimental approach using a posttest-only control group design involving 64 pregnant women recruited in September 2025 from five primary healthcare facilities in Banyuwangi, East Java,

Indonesia, consisting of three public health centers and two private midwifery practices.

Study Participants and Sample Size Calculation

A total of 72 pregnant women were assessed for eligibility. Of these, 64 were enrolled in the study. The inclusion criteria were pregnant women who (1) were in the second or third trimester of pregnancy, with a gestational age of more than 13 weeks and less than 37 weeks; (2) had low-risk, singleton pregnancy; (3) were able to read and understand the Indonesian language; and (4) owned a smartphone with internet access. No maternal age restriction was applied. Eligible women who were interested in participating were admitted to the study after giving informed consent. The exclusion criteria were pregnant women who were identified as having sensory or intellectual disabilities that might interfere with the understanding of educational materials or the completion of questionnaires. The sample size was determined using the formula for comparing the means of two independent groups:

$$n_1 = n_2 = 2 \left[\frac{(Z_{\alpha} + Z_{\beta})S}{(X_1 - X_2)} \right]^2$$

where $n_1 = n_2$ is the required sample size per group; Z_{α} is the standard normal deviate for a type I error ($\alpha=0.05$), equal to 1.96; and Z_{β} is the standard normal deviate for type II error ($\beta=0.10$), equal to 1.28. The pooled standard deviation (S) was 13.37, derived from Karamolahi et al. (2021). The expected mean difference ($X_1 - X_2$) was estimated at 12 based on clinical judgment. Substituting these values into the formula yields: $n_1 = n_2 = 2 \left[\frac{(1.96 + 1.28) \times 13.37/12}{12} \right]^2 = 26$. Therefore, the minimum required sample size of this study was 26 participants per group. Considering a 20% potential dropout rate, the final sample size was adjusted to 32 participants per group.

Sampling and Group Assignment

A voluntary sampling method was employed. Recruitment was conducted through WhatsApp groups of midwives from the five participating facilities, who disseminated the study invitation to eligible pregnant women. Both the intervention and control groups were recruited from the same five facilities. Interested women were screened according to the predefined inclusion and exclusion criteria before enrollment. Eligible participants were allocated non-randomly according to order of registration: the first 32 registrants were allocated to the intervention group, which received a single structured education session using the SisMaps interactive roadmap, and the subsequent 32 registrants to the comparison group, which received routine antenatal education.

Intervention Description

The intervention group received an educational session using "SisMaps: Your Midwifery Literacy Roadmaps", an interactive PDF-based educational media developed to enhance maternal health literacy among pregnant women. The educational content was developed by the research team, consisting of midwifery lecturers and maternal health researchers with expertise in pregnancy care and health education. SisMaps was developed from the findings of the researchers' previous qualitative study exploring the needs of the target population (Asih et al., 2026), and was further aligned with current antenatal care guidelines and relevant scientific literature. The draft materials underwent expert review by a panel of five experts: (1) a health promotion officer from the district health authority, (2) the head of the

SisMaps was designed as an interactive visual roadmap for pregnancy education. Clickable icons provide access to visuals, infographics, and animated videos covering essential topics, including early pregnancy, antenatal care, nutrition, physical activity, pregnancy warning signs, family support, childbirth and postpartum preparation, contraception, and parenting. The layout and key features are shown in Figure 1. The session was conducted once in groups, lasting approximately 1–2 hours, and was facilitated by researchers with a midwifery background and expertise in pregnancy

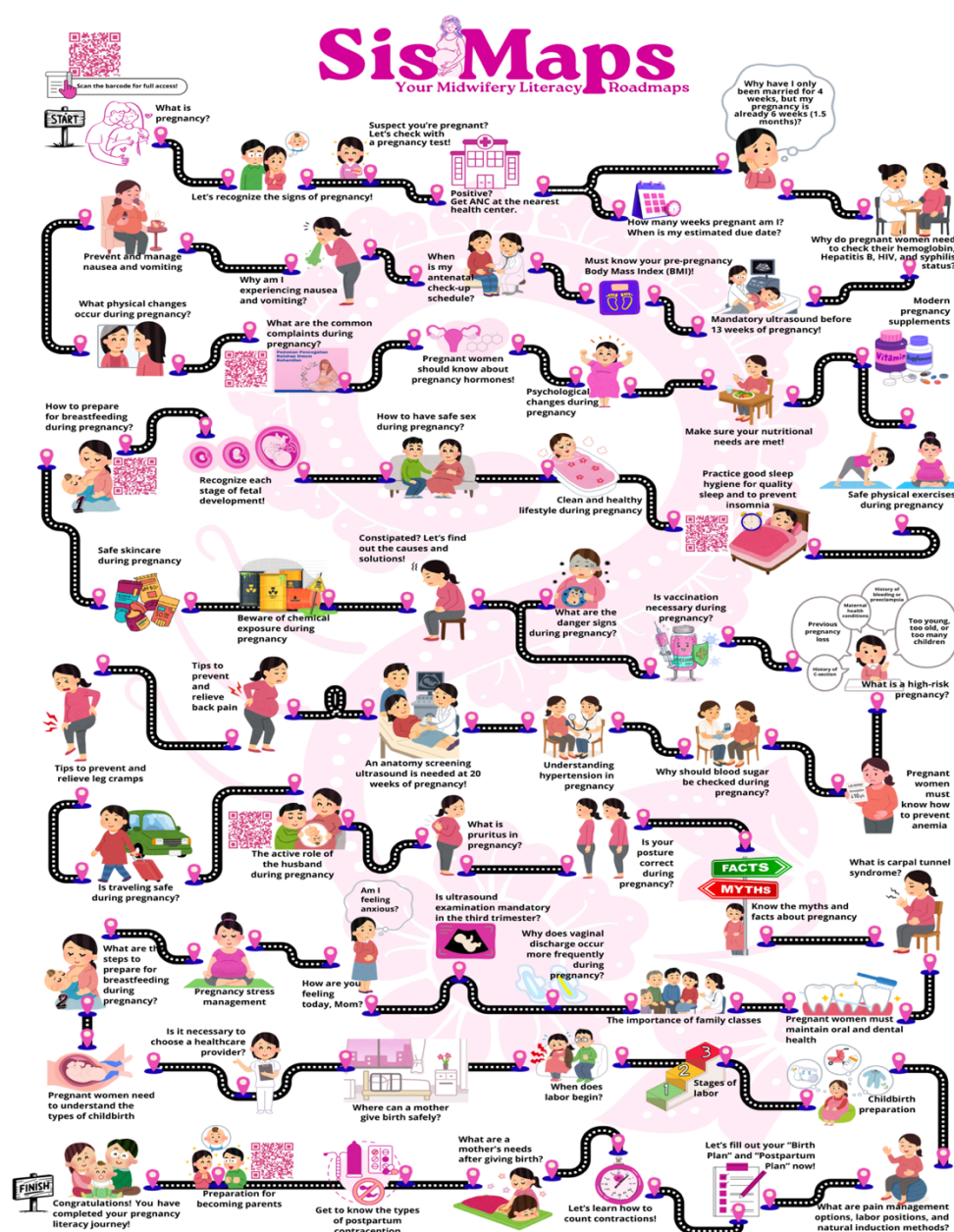


Figure 1. The layout and key features of the SisMaps digital interactive roadmap

Measurement of Maternal Health Literacy

Maternal health literacy was measured using the Maternal Health Literacy Inventory in Pregnancy (MHELIP). MHELIP was selected because it is a pregnancy-specific instrument and captures multiple dimensions of maternal health literacy relevant to the educational objectives of SisMaps, including knowledge, information-seeking, information appraisal, and decision-making and health behavior (Taheri et al., 2020). These domains correspond to the intended outcomes of SisMaps, which provides structured pregnancy-related information to support understanding, appraisal, and informed health-related decisions and behaviors. The questionnaire consists of 48 items covering four dimensions of maternal health literacy: knowledge (21 items), information-seeking (6 items), information appraisal (6 items), and decision-making and health behavior (15 items). Each statement was scored using a five-point Likert scale that indicates the subject's knowledge level and frequency of performing the behavior. A score of 5 indicates "fully knowledgeable" or "always", 4 indicates "mostly knowledgeable" or "often", 3 indicates "moderately knowledgeable" or "sometimes", 2 indicates "slightly knowledgeable" or "rarely", and 1 indicates "not knowledgeable" or "never". Raw scores for each dimension were calculated by summing the item scores and then transformed using the formula: $\text{Score} = (\text{Raw score} - \text{Minimum possible raw score}) / (\text{Maximum possible raw score} - \text{Minimum possible raw score}) \times 100$, resulting in a possible range of 0–100 for each dimension and for the total score. Higher scores represent better levels of maternal health literacy.

Validity and Reliability

The MHELIP was translated into Indonesian by a professional translation service; full cross-cultural adaptation was not performed. The Indonesian version was pilot-tested among 30 pregnant women in Banyuwangi through an online

survey. All item-total correlations exceeded the critical value ($r > 0.361$, $p < 0.05$). Cronbach's α was 0.965 for the total scale and ranged from 0.693 to 0.958 across domains: knowledge ($\alpha = 0.958$), information-seeking ($\alpha = 0.734$), information appraisal ($\alpha = 0.693$), and decision-making and health behavior ($\alpha = 0.910$).

Statistical Data Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 29 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test prior to inferential analyses. Categorical variables were presented as frequencies and percentages, and continuous variables as mean $\pm$ standard deviation (SD). Categorical variables were compared using the chi-square test with continuity correction or Fisher's exact test, education level (ordinal) using the Mann-Whitney U test, and continuous variables using the independent samples t-test or Mann-Whitney U test, depending on data distribution. For the main outcomes, mean differences with 95% confidence intervals and Cohen's d were reported. Statistical significance was set at a two-tailed $p < 0.05$.

RESULTS OF STUDY

Pregnant Women Characteristics

A total of 64 pregnant women participated in this study, consisting of 32 women in the intervention group and 32 women in the control group. There were no dropouts in either group (Figure 2). Most participants were between 21 and 33 years old. Baseline characteristics were compared between the two groups (Table 1). There were no statistically significant differences in baseline characteristics between the groups ($p > 0.05$).

Table 1. Characteristics of pregnant women

Characteristics	Intervention (n=32)	Control (n=32)	P-value
Age			0.107 ^a
Mean (SD)	27.72 (4.96)	25.81 (4.34)	
Gestational Age			0.283 ^a
Mean (SD)	25.72 (6.86)	23.88 (6.76)	
Gravidity			0.452 ^b
Primigravida	17 (53.1%)	13 (40.6%)	
Multigravida	15 (46.9%)	19 (59.4%)	
Education			0.939 ^c
Elementary and Junior High School	5 (15.6%)	3 (9.4%)	
Senior High School	17 (53.1%)	21 (65.6%)	
Higher Education	10 (31.3%)	8 (25%)	
Work			1.000 ^d
Employed	5 (15.6%)	6 (18.7%)	
Not Employed	27 (84.4%)	26 (81.3%)	
Delivery mode			0.617 ^b
Offline	14 (43.7%)	17 (53.1%)	
Online	18 (56.3%)	15 (46.9%)	

Notes: a = Independent samples t-test, b = Chi-square test, c = Mann-Whitney U test, d = Fisher's exact test

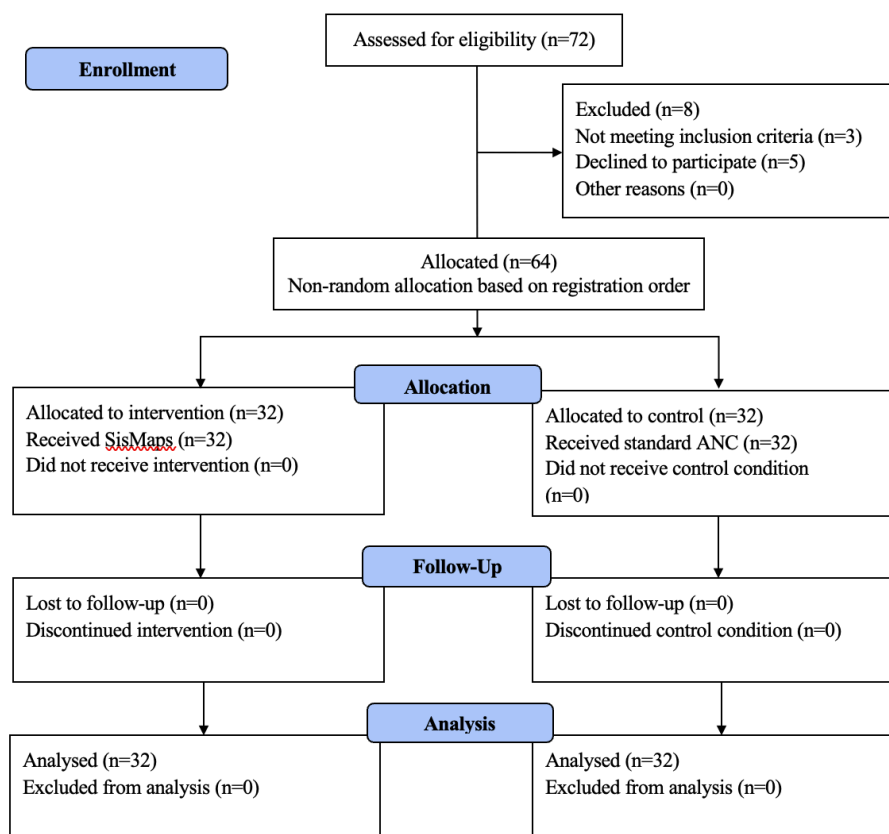


Figure 2. Flow Diagram of the Quasi-Experimental Study

Table 2. Analysis of differences in maternal health literacy during pregnancy

Maternal Health Literacy	Mean (SD) Intervention (n=32)	Mean (SD) Control (n=32)	Mean Difference (95% CI)	Cohen's d	P-value
Maternal health knowledge	75.34 (16.99)	55.88 (15.22)	19.46 (11.40-27.52)	1.21	<0.001 ^a
Maternal health information seeking	74.53 (12.56)	65.75 (13.34)	8.78 (2.30-15.26)	0.68	0.009 ^a
Maternal health information appraisal	81.22 (12.61)	67.59 (16.46)	13.63 (6.29-20.97)	0.93	<0.001 ^b
Maternal health decision-making and behavior	88.16 (10.29)	79.94 (11.01)	8.22 (2.89-13.55)	0.77	<0.001 ^b
Total maternal health literacy score (MHELIP)	80.01 (12.04)	66.12 (11.63)	13.89 (7.97-19.81)	1.17	<0.001 ^a

Notes: a = Independent samples t-test, b = Mann-Whitney U test.

MHELIP = Maternal Health Literacy Inventory in Pregnancy. The instrument consists of 48 items: knowledge (21 items), information seeking (6 items), information appraisal (6 items), and decision-making and behavior (15 items). Items are rated on a 5-point Likert scale. Scores are expressed on a 0–100 scale (percentage of the maximum possible score); higher scores indicate better health literacy.

Intervention Effects

Primary outcome. The total MHELIP score was higher in the intervention group than in the control group (80.01 ± 12.04 vs 66.12 ± 11.63; mean difference 13.89, 95% CI 7.97–19.81; Cohen's d = 1.17; p<0.001; Table 2). Secondary outcomes. In the individual domains, scores in the intervention group were higher for knowledge (75.34 ± 16.99 vs. 55.88 ± 15.22; mean difference 19.46, 95% CI 11.40–27.52; p<0.001), information-seeking (74.53 ± 12.56 vs. 65.75 ± 13.34; mean difference 8.78, 95% CI 2.30–15.26; p=0.009), information appraisal (81.22 ± 12.61 vs. 67.59 ± 16.46; mean difference 13.63, 95% CI 6.29–20.97; p<0.001), and decision-making (88.16 ± 10.29 vs. 79.94 ± 11.01; mean difference 8.22, 95% CI 2.89–13.55; p<0.001). These findings indicate that the

women who received SisMaps had higher maternal health literacy scores than those who received routine antenatal education.

DISCUSSION

The findings of this study indicate that SisMaps, a pregnancy education roadmap tool, was associated with higher maternal health literacy (MHL) among pregnant women across all subscales—knowledge, information seeking, information appraisal, and decision-making. The significant differences in MHELIP scores between the intervention and control groups suggest that structured, interactive, and easy-

to-follow pregnancy education media may support mothers' ability to understand and use health information. These results align with previous evidence demonstrating that digital and visual educational media may help bridge literacy gaps and support decision-making abilities (Mulyani et al., 2024). A randomized controlled trial of a structured mobile application likewise reported improved health literacy among pregnant women after an eight-week intervention (Karamolahi et al., 2021). However, because the benefit of digital education for maternal health literacy has been widely demonstrated, the contribution of the present study lies less in the digital format itself than in how the information is organized. SisMaps arranges pregnancy information as a roadmap, which may offer a different and potentially useful way of structuring pregnancy education.

Higher knowledge scores may reflect the systematic learning flow provides by the roadmap structure within SisMaps. Prior studies have emphasized that many educational media still present information in a fragmented manner, which limits mothers' understanding of the continuum of pregnancy care (Bharadwaj & Kaur, 2015; Whitworth et al., 2024). By organizing content sequentially from early pregnancy to postpartum, SisMaps may facilitate easier comprehension of the entire pregnancy journey. Such sequencing may also make information easier to process and remember, although this was not measured in this study and should be regarded as a possible explanation rather than an observed effect. The higher information-appraisal scores suggest that interactive media may help mothers assess the credibility of information. The difference in information seeking was smaller (Cohen's $d = 0.68$ vs. 1.21 for knowledge), which suggests that a roadmap may be better at organizing information that is already provided than at prompting mothers to look for new information. Visual features, clickable icons, and the integration of videos and infographics may enhance learning motivation and autonomy, as supported by previous research on digital learning for pregnant women (Feldman et al., 2024; Karamolahi et al., 2021; Mulyani et al., 2024); however, motivation and autonomy were not assessed in this study. Regarding decision-making, the higher scores in the intervention group suggest that structured understanding may help mothers make more informed health decisions, which may be relevant to behaviors such as ANC adherence, recognition of danger signs, and birth preparedness. These findings are in line with existing literature showing that higher MHL is associated with healthier behaviors and better pregnancy outcomes (Aslantekin et al., 2019; Dayyani et al., 2019; Lori et al., 2014).

This study suggests that roadmap-based education may be useful option for antenatal education. SisMaps, which can be used both online and offline, may be applicable in midwifery practice as a tool to support midwives' educational role, although feasibility was not evaluated. Despite these promising findings, this study has several limitations. First, participants were recruited through voluntary sampling and allocated non-randomly based on registration order, which may have introduced selection bias and baseline differences between groups. Second, the posttest-only design lacked baseline measurement of maternal health literacy (MHL), so group equivalence could not be verified and change from baseline could not be assessed. Third, the sample was small ($n = 64$) and recruited from a single region, which limits statistical power and the generalizability of the findings. Fourth, MHL was self-reported and may be subject to social desirability bias. Fifth, participants in both groups were recruited through midwives' WhatsApp groups and the

SisMaps PDF was distributed via WhatsApp, so information or materials may have reached the control group, even though participants agreed beforehand not to share information about SisMaps. Sixth, the intervention group received a dedicated session with interactive discussion delivered by researchers with midwifery expertise, whereas the control group received routine antenatal education; therefore, attention effects and facilitator effects cannot be excluded. The Indonesian version of the MHELIP was not fully cross-culturally adapted, and its psychometric testing was limited to 30 respondents; further validation, including construct validity, is needed. Finally, the intervention was delivered in a single session and MHL was measured approximately two hours afterward. The findings may therefore primarily reflect short-term knowledge acquisition and should not be interpreted as evidence of retained health literacy, which would require follow-up assessment. Taken together, selection bias, baseline imbalance, and immediate recall (as MHL was measured approximately two hours after the session) may offer alternative explanations for the observed score differences. Future studies are recommended to adopt randomized controlled designs, employ pretest–posttest measurements, and conduct follow-up evaluations to examine sustained impacts and user experiences. Overall, this study provides preliminary evidence that a roadmap-based pregnancy education tool may be associated with higher maternal health literacy scores immediately after the session. Its use in antenatal education and midwifery practice requires confirmation in more rigorous designs, and effects on maternal outcomes, feasibility, cost-effectiveness, and large-scale implementation were not evaluated.

CONCLUSIONS AND RECOMMENDATION

This study found that participation in the pregnancy education roadmap was associated with higher post-intervention maternal health literacy (MHL) scores measured shortly after a single session compared with the control group across key domains, including knowledge, information seeking, information appraisal, and decision-making. SisMaps shows potential as a structured and interactive pregnancy education medium for antenatal education in midwifery practice. Its long-term effectiveness needs to be confirmed in future studies incorporating baseline assessment, randomization, and follow-up evaluation.

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DECLARATION

Ethics approval and consent to participate

This study has received ethical approval (212/02/KEPK-STIKSBWI/VI/2024-2025) from the Health Research Ethics Committee of STIKES Banyuwangi (Universitas Dr. Soekardjo, Banyuwangi, East Java, Indonesia).

Consent for publication

Not applicable. This manuscript does not contain any identifiable personal data, images, or other information requiring consent for publication.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of interest Statement

The authors declare that they have no competing interests.

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Artificial Intelligence-Assisted Technology

The authors used ChatGPT (OpenAI) solely to improve the language, grammar, and readability of the manuscript. No artificial intelligence-assisted technology was used in the study design, data collection, data analysis, interpretation of the results, or drawing the conclusions. The authors take full responsibility for the content of the manuscript.

Authors' contributions

Fransisca Retno Asih led the conceptualization and methodology of the study, secured the research funding, supervised the overall study process, conducted the formal data analysis, validated the findings, prepared the visualizations, wrote the initial draft of the manuscript, and critically reviewed and edited the manuscript. **Nuristy Brilliant Ainindyahsari Winarna** contributed to the conceptualization and methodology, coordinated the project administration, participated in the investigation and data curation, provided the study resources, and contributed to the initial draft of the manuscript. **Indah Christiana** participated in the investigation and data curation, contributed to the formal analysis and validation of the findings, provided the study resources, and contributed to the initial draft of the manuscript. All authors reviewed and approved the final version of the manuscript.

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