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Developing and testing a mobile application for imparting knowledge: the positive birth experience guideline to midwifery students

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Abstract

Background Given the importance of the care provided during labour and childbirth and its impact on the childbirth experience, as well as the fact that proper training of midwives can improve the quality of care, this study aims to design World Health Organization guideline for positive childbirth experience in the form of a mobile application (Phase One) and examine its effectiveness in imparting knowledge among midwifery students (Phase Two).

Methods This study employed a research and development methodology. In the initial phase, the "Positive Birth Experience Application" was designed based on the WHO recommendations for the intrapartum period. The second phase utilized a one-group pretest-posttest design. After one month of using the application, 30 midwifery students from Tabriz University of Medical Sciences in Tabriz, Iran completed knowledge (posttest) and evaluation questionnaires. The data was analyzed using SPSS Version 24 software. A Paired Samples T-test was conducted to assess the students' knowledge before and after the intervention.

Results The results of the pilot study showed a statistically significant difference ($P < 0.001$) in the mean knowledge scores of the students regarding the WHO guideline before and after the intervention. After the intervention, the students had higher knowledge scores compared to before using the application [(Mean Difference = 4.75; (95% Confidence Interval = 3.56 to 5.93)]. The analysis for the evaluation of the application indicated that the highest mean (SD = Standard Deviation) scores were observed for the information quality and system quality subscales, which were 50.7 (8.03) and 47.9 (11.6), respectively. In contrast, the lowest mean (SD) scores were associated with the service quality and user satisfaction subscales, which were 23.9 (7.43) and 25.6 (6.62), respectively.

Conclusions The positive birth experience application can be used as an educational method to increase students' knowledge of the recommendations of the WHO regarding intrapartum care. The evaluation of this application by the students demonstrated that it can provide valuable and high-quality information related to intrapartum care, thus enhancing their knowledge in this area.

Keywords Midwifery, Mobile apps, Smartphone, Birth satisfaction, World health organization

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Background

The World Health Organization (WHO) defines a positive childbirth experience as fulfils or exceeds a woman's prior personal and sociocultural beliefs and expectations, including giving birth to a healthy baby in a clinically and psychologically safe environment with continuity of practical and emotional support from a birth companion(s) and kind, technically competent clinical staff [1]. A positive childbirth experience plays a significant role in self-efficacy, self-esteem [2], maternal-infant attachment [3], maternal functioning [4], and decision-making regarding future reproduction and vaginal birth [5].

Factors such as the provision of respectful and continuous care by a supportive midwife [6–8], based on the needs and preferences of women [9, 10], reducing unnecessary interventions [11], perceived internal and external control [12], professional support [13], and skin-to-skin contact [14] are associated with a positive childbirth experience. WHO has presented a guideline in 2018 with the aim of creating a positive childbirth experience for women. The guideline provides recommendations regarding the provision of care during labour and childbirth, including the first, second, and third stages of labour, as well as newborn care and postnatal maternal care [1].

Digital technologies can enhance women's satisfaction with pregnancy and childbirth. For example, mobile applications can provide information about pregnancy and childbirth [15, 16], assist them in tracking their symptoms and care timelines, and facilitate communication with their healthcare providers [17]. Websites and social media platforms can also create opportunities for connecting with other women who have similar experiences [18–20].

The COVID-19 pandemic has led to changes in medical education, continuous medical education activities, residency and fellowship programs, and specialty society meetings. It has also normalized online learning and the use of digital technologies. Blended learning approaches that combine digital technologies with in-person instruction, designed and implemented based on evidence, can contribute to improving the quality of education and student learning [21].

Smartphones and their associated software have played a crucial role in delivering healthcare services and have impacted healthcare delivery models as well as traditional barriers to accessing information and services [22–25]. Many medical applications have been developed for smartphones and are widely used by health professionals and patients [26]. Smartphones and mobile applications have also been used for communication, medical education, clinical decision-making, and drug reference purposes [27]. Some studies have shown that the use of applications by midwives and other women's healthcare providers can lead to improved quality of care [28]. Midwives consider mobile devices as important tools for their educational and professional activities due to their audio, text-based functionalities, as well as access to email [29].

Women's satisfaction with childbirth is considered an indicator of the quality of care [30, 31]. The quality of care can significantly impact the childbirth experience. Recently, a systematic review has recommended further studies on the use of digital education to enhance the training of nursing and midwifery students [32]. Therefore, the present study aimed to design a mobile application-based guideline for positive childbirth experience formulated by the WHO, evaluate it, and assess its effectiveness on the imparting knowledge among midwifery students.

Methods

Study design and participants

This study employed a research and development approach, conducted in two distinct phases. In the developmental phase, the mobile application was created based on WHO guidelines for positive childbirth experiences. Following this, the application was tested and evaluated among a group of midwifery students using a one-group pretest-posttest design. The primary outcome measured was the change in knowledge scores, while the secondary outcome focused on the evaluation of the application. The design and development of the mobile application occurred from June 2022 to January 2023, with the effectiveness assessment on the knowledge scores of the midwifery student participants taking place from January to March 2023.

Process and steps of application design

The mobile application was designed based on the recommendations provided in the WHO's guideline for a positive childbirth experience. The application was educational and interactive, presenting enhancing elements of the childbirth experience (such as respectful maternal care, available options for pharmacological and non-pharmacological pain relief, etc.) in the form of animations and flashcards. Additionally, key points were created as notifications to provide important information to the users.

The objective of the project was to develop an Android application utilizing the Kotlin programming language. The application architecture utilized was Google's recommended architecture, known as MVVM (Model-View-View Model). This architecture is a software design pattern that facilitates the separation of the user interface from business logic and data model components.

The model layer serves as the data access layer, responsible for retrieving the stored data from the local database on the device. This data is then provided to the view

layer for display to the user. The view layer is responsible for displaying the user interface. The ViewModel layer acts as an intermediary between the other two layers, retrieving the data from the model layer that needs to be displayed in the view. One advantage of this architecture is that the ViewModel caches the data and state, fetched once by the view layer, even during configuration changes like screen rotation. This ensures that the view doesn't need to reload the data when navigating between view layers or during screen rotation (Figs. 1 and 2).

Development stages

1. **Needs Assessment**: Initial surveys and focus groups were conducted to identify the specific educational needs of midwifery students related to childbirth.
2. **Content Development**: Educational materials were created based on the WHO guidelines, covering various aspects of care during labor and childbirth.
3. **Prototype Design**: A prototype of the application was developed, incorporating animations and interactive elements.
4. **Expert Review**: Feedback from experts in midwifery, reproductive health, and Health Information Technology was sought during the prototype phase to ensure the content's validity and relevance.
5. **Final Adjustments**: Based on the feedback from experts, final adjustments were made to enhance the application's performance and user experience.
6. **Pilot Testing**: The study employed a one-group pretest-posttest design for this stage of the investigation.

Following the development of the application, the study objectives and implementation procedures were thoroughly explained to 30 s- and third-year midwifery students at Tabriz University of Medical Sciences, selected through convenience sampling. After obtaining informed consent and confirming eligibility, participants completed self-administered questionnaires assessing

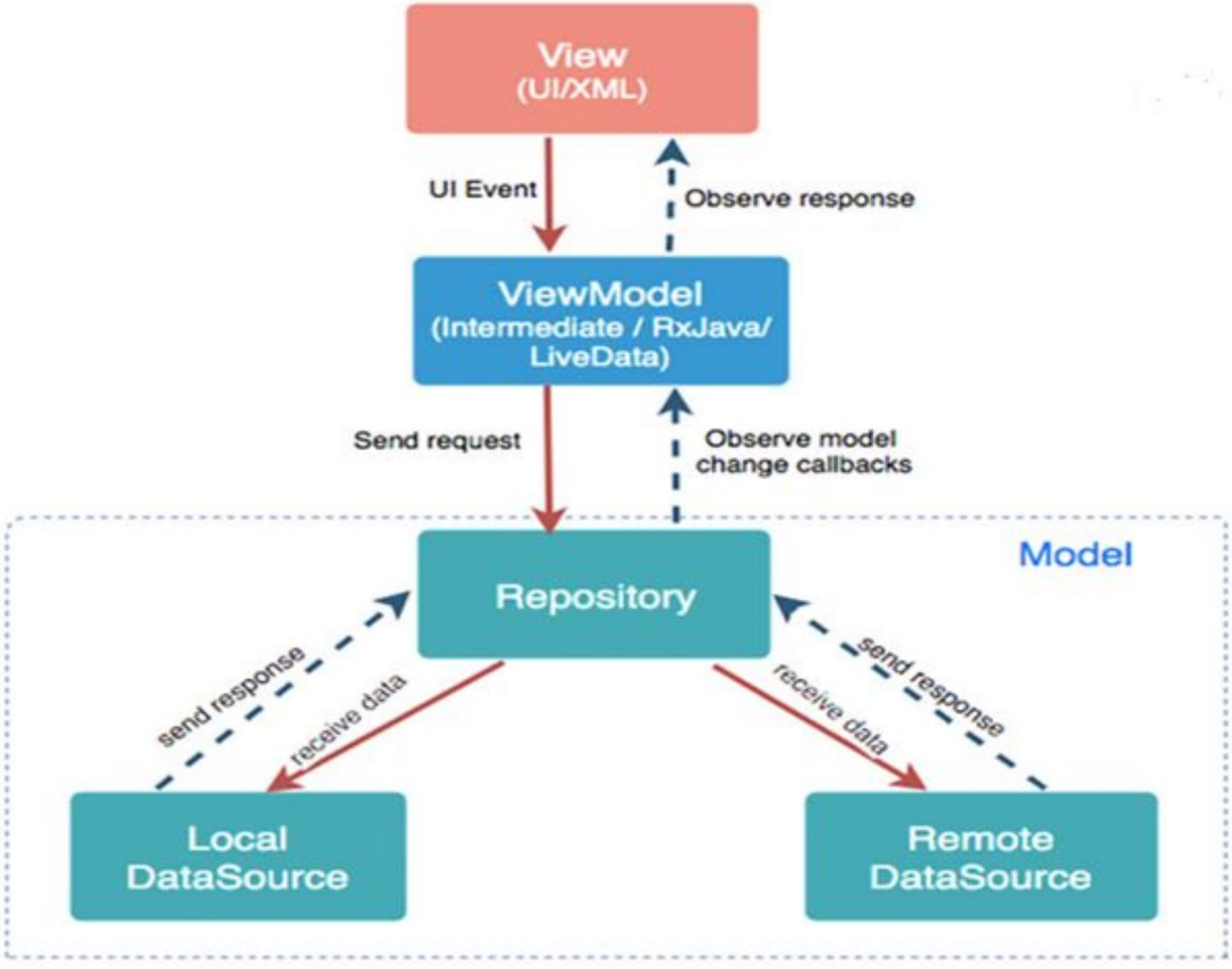

Fig. 1 Software design pattern

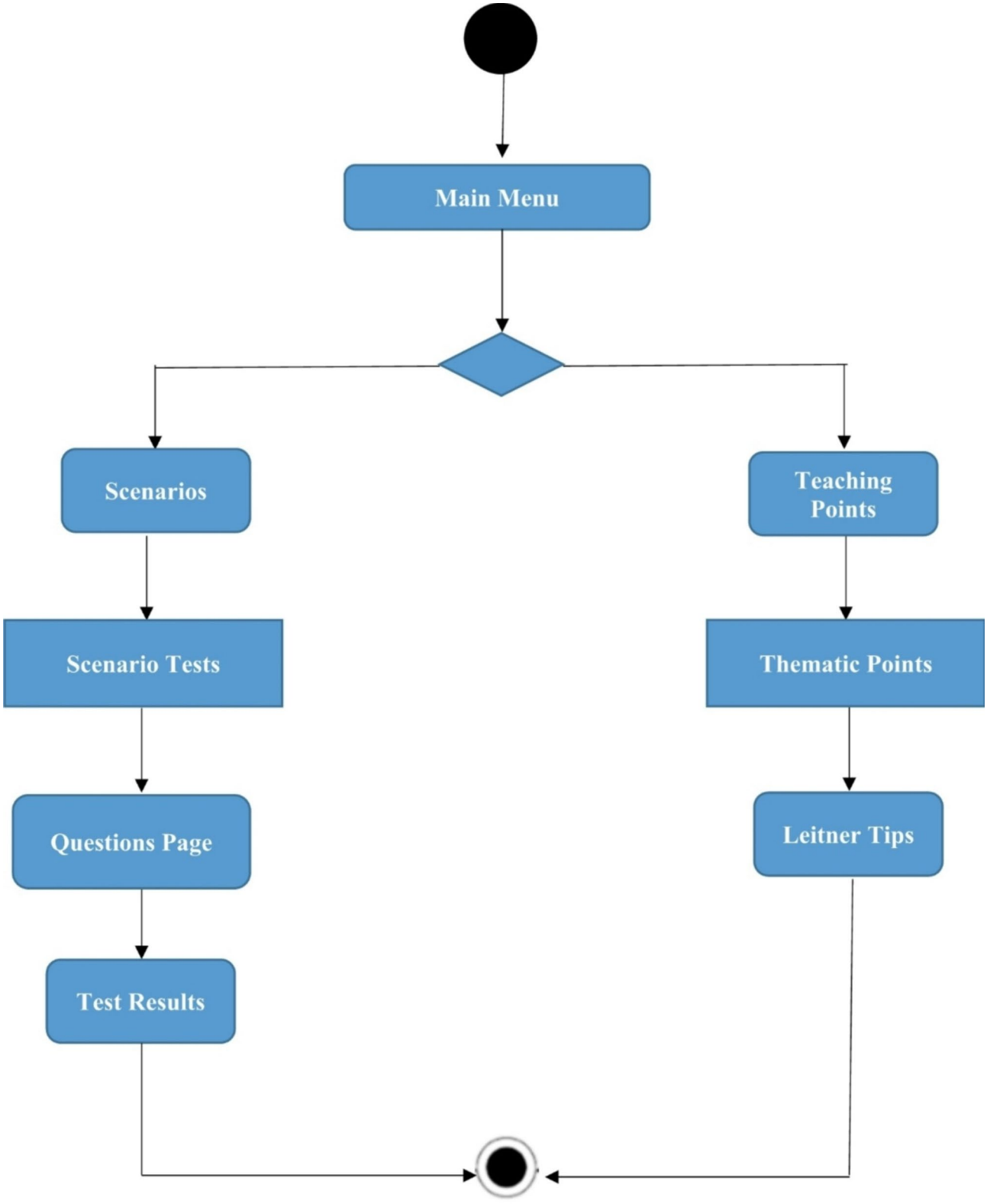

Fig. 2 The process of using the application on the mobile screen

personal-social characteristics and baseline knowledge (pre-test). The application was installed on participants' Android mobile devices via a provided link (https://s30.picofile.com/file/8469595426/app_release.apk.html), and access was granted for 30 days. Although actual usage was not logged due to technical limitations, reminder messages were sent to encourage consistent engagement with the application. On the 30th day, post-test knowledge assessments and evaluation questionnaires were administered to measure changes in knowledge.

In the application, midwifery students must initially access the designed sections of the application by entering their information. On the home page, the user is presented with a user-friendly menu consisting of two sections. One section focuses on user training and includes educational materials presented continuously in the form of flashcards. Users are regularly reminded of the material daily until they confirm that they have learned it. Once the material is confirmed as learned, it is only reminded to the user on a monthly basis. The educational materials were based on the WHO guidelines, covering various aspects of care during labor and childbirth. These recommendations included four related to care during labor and childbirth, 26 for the first stage, seven for the second stage, six for the third stage, five for newborn care, and five for postnatal maternal care. The students were required to review these points.

In the next stage, the authors designed seven exams in the form of scenarios. These scenarios and exams were reviewed by ten professors specializing in midwifery and reproductive health, and their feedback was incorporated into the final versions. The first scenario included care during labor and childbirth (10 questions); the second scenario (6 questions); and the third scenario (10 questions) covered care during the first stage of labor. The fourth scenario (6 questions) and the fifth scenario (4 questions) focused on care during the second stage of labor. The sixth scenario (6 questions) included care during the third stage of labor, and the seventh scenario covered postnatal maternal care (5 questions). These scenarios were designed based on WHO recommendations, with answers categorized as "recommended," "not recommended," or "not feasible considering the current context/situation," as per the guidelines. Before moving on to the next scenario or viewing the answers to the questions, it was not possible to complete the scenario and obtain an acceptable grade. After completing each scenario, incorrect answers were displayed along with explanations related to the questions. The minimum acceptable grade to proceed to the next scenario was achieving at least 60% of the score from the previous scenario (Fig. 3). If the minimum grade was not achieved, the student had to revisit that scenario and answer the questions again. The validity of the application was assessed through content and visual validity.

Setting and eligible criteria

The Nursing and Midwifery College of Tabriz was established in 1916. The faculty is a public (state-run) college that currently has 650 undergraduate students across three majors: Nursing, Midwifery, and Operating Room Technology. Midwifery student admissions occur on an annual basis.

The inclusion criteria were being second and third-year midwifery students, having an Android mobile phone, and wanting to participate in the study while the exclusion criteria were non-response to more than 20% of the questionnaire items.

Sample size

The total number of midwifery students in the second (12 students) and third (18 students) years of the undergraduate program at Tabriz University of Medical Sciences was 30 students. To determine the sample size, Slovin's formula was applied, as there was no previous assessment regarding our outcome.

$$\mathbf{n} = \frac{\boldsymbol{N}}{1 + \boldsymbol{N} * \propto^{2}}$$

The minimum required sample size with an error ($\propto$) of 0.06 was calculated to be 27 people, and considering a 10% dropout rate, the final sample size was set at 30 people. In other words, a census method was used.

Instruments

To collect data in this study, a checklist of inclusion and exclusion criteria, as well as questionnaires for socio-demographic characteristics, knowledge, and application evaluation (based on the DeLone and McLean model), were used.

Socio-demographic questionnaire

This questionnaire included questions on age, marital status, housing status, level of education and occupation of parents, education at the same time as employment, adequacy of family income for living expenses and interest in midwifery.

Student's knowledge scores questionnaire

The questionnaire for assessing the score of knowledge among students consisted of 20 questions covering various areas including care during labour and birth (2 questions), the first stage of labour (7 questions), the second stage (4 questions), the third stage (3 questions), newborn care (2 questions), and postpartum maternal care (2 questions). Before the main study, the questionnaire was

Fig. 3 A view of the Positive Birth Experience Application

piloted with a small group of 10 midwifery students who were not part of the main study. The pilot test aimed to assess the clarity, and comprehensibility of the questionnaire. Based on the feedback from the pilot test, minor adjustments were made to improve the wording of some questions. The questionnaire was designed based on the content of the positive birth experience guideline by the WHO. Each question had four options, with one correct answer. The attainable score was 0 to 20. The students completed the questionnaire once before using the application and again after one month of using the application. The duration of the test was set to 20 minutes. The Cronbach's alpha value for the questionnaire was calculated to be 0.70, indicating good internal consistency and reliability. The content validity of the questionnaire was examined through the review and input of a panel of 10 experts in midwifery and reproductive health. These findings suggest that the questionnaire is a valid and reliable instrument for assessing students' knowledge in the relevant domain."

Application evaluation questionnaire based on DeLone and McLean model

The application evaluation questionnaire is based on the DeLone and McLean model introduced in 2003 and consists of 23 questions covering six key dimensions: system quality, information quality, service quality, user utilization, satisfaction, and usefulness. Specifically, the questionnaire evaluates system quality through questions 1–5, information quality through questions 6–10, service quality through questions 11–13, system use through questions 14–16, user satisfaction through questions 17–19, and the overall beneficence of the system through questions 20–23. Respondents provide their feedback on a 4-point scale ranging from "strongly disagree" to "strongly agree" [33]. Furthermore, the validity and reliability of this questionnaire have been well-established in

the Iranian context, with Hatami et al. reporting a Cronbach's alpha coefficient of 0.82, indicating strong internal consistency [34]. To enable a comparative evaluation of the subscale scores, we converted all subscale scores to a common 0-100 range. This allowed for a more meaningful comparison of the relative performance across the different evaluation criteria.

Table 1 Sociodemographic characteristics of students ($N=28$)

Variable	Frequency ($N=28$)	Percentage ($N=28$)
Age (years) Mean ± SD	**21.4**	**1.5**
Marital status		
Single	28	100
Housing situation		
Native	17	60.7
Dormitory	11	39.3
Year of study of students		
Second	12	42.9
Third	16	57.1
Education at the same time as employment		
No	28	100
Father's education		
Primary education	1	3.6
Secondary education	5	17.9
High school	2	7.1
Diploma	7	25
Academic	13	46.4
Father's job		
Unemployed	2	7.1
Worker	1	3.6
Employee	10	35.7
Other (self-employment)	15	53.6
Mother's education		
Primary education	3	10.7
Secondary education	2	17.9
High school	5	10.7
Diploma	8	28.6
Academic	9	32.1
Mother's Job		
Housewife	22	78.6
Employed	6	21.4
Adequacy of family income		
Insufficient	2	7.1
Relatively sufficient	15	53.6
Thoroughly sufficient	11	39.3
Place of residence		
City	28	100
Interested in Midwifery		
Very much interest	3	10.7
High interest	7	25
Moderate interest	16	57.1
Little interest	2	7.1

SD: Standard Deviation

Statistical analysis

After data collection in the pilot study, the SPSS software, Version 24, was utilized for data analysis. Descriptive statistics, including frequencies (percentage) and means (standard deviation), were used to describe the sociodemographic characteristics and evaluation domains of the application. Furthermore, a Paired Samples t-test was employed to assess the score of knowledge before and after the intervention. A p-value less than 0.05 was considered to be statistically significant.

Results

The study sample consisted of 30 undergraduate midwifery students, with 12 students in their second year and 18 students in their third year. Two participants were excluded from the study due to responding to less than 20% of the questionnaire items. The mean (SD) age of the students was 21.4 years = 5.1). All students were unmarried. The majority of them had a moderate level of interest in the field of midwifery (Table 1).

Knowledge score of students

The results of the Paired Samples T-test indicated a statistically significant difference ($P<0.001$) in the mean knowledge scores of the students regarding the WHO guideline before and after using the application. The mean difference was 4.75, with a 95% confidence interval ranging from 3.56 to 5.93. This demonstrates that the application was effective in enhancing the students' understanding of the WHO guidelines.

Further analysis revealed that the students' knowledge scores were significantly higher after using the application across all sections of the questionnaire, with the exception of the Postpartum maternal care section ($p=0.678$). Statistically significant improvements were observed in the sections covering labour and birth care ($p=0.026$), first stage of labour care ($p<0.001$), second stage care ($p<0.001$), third stage care ($p<0.001$), and newborn care ($p=0.032$) (Table 2).

Application evaluation

The results analysis indicated that the highest mean (SD) scores were observed for the information quality and system quality subscales, which were 50.7 (8.03) and 47.9 (11.6), respectively. These subscales had scores ranging from 4.35 to 65.2. In contrast, the lowest mean (SD) scores were associated with the service quality and user satisfaction subscales, which were 23.9 (7.43) and 25.6 (6.62), respectively. These subscales had scores ranging from 8.70 to 34.7, and 13.0 to 39.1, respectively (Table 3).

Table 2 Pre-post comparison of the knowledge of students (*N* = 28)

Variable	Pre-test	Post-test	MD 95%CI	*P*-value
	Mean (SD)	Mean (SD)		
Labour and birth care	1.25 (0.70)	1.57 (0.69)	0.32 (0.41 to 0.60)	0.026
First stage of labour	2.50 (1.62)	4.39 (1.49)	1.89 (1.17 to 2.61)	< 0.001
Second stage care	1.89 (1.06)	3.28 (0.89)	1.39 (0.90 to 1.88)	< 0.001
Third stage care	1.64 (0.82)	2.53 (0.63)	0.78 (0.41 to 1.15)	< 0.001
Newborn care	1.28 (0.65)	1.57 (0.57)	0.39 (0.03 to 0.74)	0.032
Postpartum maternal care	1.32 (0.66)	1.25 (0.70)	0.07 (-0.42 to 0.27) -	0.678
Total score	9.90 (2.33)	14.65 (3.40)	4.75 (3.56 to 5.93)	< 0.001

MD Mean Difference, CI Confidence Interval, SD Standard Deviation

Table 3 Application evaluation based on DeLone and McLean model (*N* = 28)

Variables	Mean (SD)*
System Quality	47.9 (11.6)
Information Quality	50.7 (8.03)
Quality of Service	23.9 (7.43)
System use	31.2 (6.15)
Satisfaction	25.6 (6.62)
Beneficence	38.3 (8.85)

SD Standard Deviation; * Attainable Score was 0 to 100

Discussion

The results of the present study demonstrated that the positive birth experience application was effective in increasing the knowledge of midwifery students regarding standard care during labor and childbirth, with the exception of the postpartum maternal care section. This finding is consistent with previous studies that have shown the positive effects of using mobile applications for learning and knowledge acquisition among students. A number of studies have reported that students provide positive feedback and evaluations regarding the use of mobile devices and applications in clinical education. Most students utilize smartphone applications to assist in their clinical practice and have previously engaged in such activities [35].

The use of technology has been found to be convenient for students, providing them with easy access to resources and facilitating evidence-based clinical decision-making [36]. For example, a study evaluating the "KeGawatDaruratan" (KGD) mobile application developed for midwifery students found that approximately 69.6% of the students found the application helpful in their learning process concerning maternal and neonatal emergencies, and 73.2% evaluated it as easy to use [37]. Similarly, a quasi-experimental study by DeLeo et al. (2018) demonstrated that the use of smartphones enhanced the learning and clinical experience of graduate-level midwifery students [38]. Additionally, a randomized controlled trial by Aksoy Derya et al. (2021) found that the use of a web and mobile-based software system called Midwifery Clinical Automation significantly increased the motivation and time management of midwifery students, although there was no significant difference in anxiety levels between the intervention and control groups [39]. While medical students in Malaysia were found to have a high level of awareness regarding mHealth applications related to medical education, health and fitness, and management programs (including COVID-19), their actual utilization of these applications was relatively low [40]. In contrast, a mixed-method study by Meedya et al. demonstrated that the transformation of The Milky Way Program into a mobile health application was well-received, with users finding the application easy to use, interactive, and providing credible information [41].

However, in some studies, the use of the mobile application did not result in a statistically significant improvement in students' knowledge and awareness. In a randomized controlled clinical trial (2016) conducted by Carolina Fernández-Lao and colleagues, the use of a mobile application for physiotherapy students in acquiring shoulder palpation and ultrasound skills did not lead to a significant between-group difference in the acquisition of theoretical knowledge [42]. Additionally, in another randomized controlled trial by Richard D. Bartlett et al. (2017), third-year medical students were randomly assigned to three groups: The Touch Surgery mobile application simulator, no formal review resources, and traditional review resources. Their abilities were evaluated in completing a male urinary catheterization scenario. However, when comparing the mean score improvement (knowledge) between the groups, there was no statistically significant difference [43]. Furthermore, Ismail SN, et al. (2018) evaluated a mobile application for occupational safety and health information among university students and staff, with the aim of replacing the use of conventional notice boards in this study. The results showed that the mobile application did not have a significant impact on the respondents' perceived performance [44].

The results of the student evaluation indicate that the application was able to provide suitable information to the students, as reflected in the high scores for the information quality and system quality subgroups. However,

the lower scores for service quality and overall satisfaction suggest areas for improvement. Previous studies have found that the quality of the system, information, and services, as well as user satisfaction, are all important factors in the success of an electronic learning system [45]. For example, Mutiah et al. showed that the use of a mobile application for documenting midwifery care led to increased ease and satisfaction for students [46]. Similarly, another study found high satisfaction among midwife staff using a mobile emergency guide application [47]. Rokhman et al. concluded that e-learning systems should focus on improving not only information and system quality, but also service quality, student satisfaction, and the capabilities of both students and teachers [48]. This suggests that a multifaceted approach to system design and evaluation is needed to ensure a positive user experience.

The differences in findings across studies may be due to variations in the specific applications evaluated, the user populations, and the evaluation methodologies employed. Further research is needed to better understand the key drivers of user satisfaction and engagement with electronic learning systems.

One of the strengths of the current study is the evidence-based design of the application to enhance women's childbirth experiences and improve the education of midwifery students. Several studies have also demonstrated that the use of credible guidelines in the design of mobile applications leads to increased learning, effective impact, and adherence among the target group [49–51]. For example, studies examining mobile applications for preventing depression, suicide, or smoking cessation have shown that very few of these applications provide evidence-based information. Therefore, adherence to guidelines should be ensured in the design of applications to maximize benefits and minimize harm to users [52, 53].

Given that this application is readily accessible, midwifery instructors can utilize it as an educational resource to enhance students' knowledge of strategies for improving childbirth satisfaction. However, this study has several limitations. First, the lack of a control group, due to the pilot nature of the application implementation and the potential for contamination in a single public nursing and midwifery school in Tabriz, limits the generalizability of the findings. Second, while this study focused on knowledge acquisition, it did not evaluate the translation of this knowledge into practical caregiving skills or improvements in clinical performance. Additionally, the assessment of neonatal care was limited to only two questions, which may not fully capture the breadth of neonatal issues outlined in the WHO guidelines. Future research should address these limitations by conducting randomized controlled trials, incorporating direct observation of students' clinical performance to assess the application's impact on both knowledge and practical skills, and expanding the evaluation of neonatal care to include a more comprehensive assessment aligned with WHO recommendations.

Conclusion

The positive birth experience application can serve as an effective educational method to increase the knowledge of midwifery students regarding intrapartum care. The evaluation of this application by students has demonstrated its potential to provide useful and high-quality information to students. It is recommended to test this app in other groups, such as obstetrics and gynecology residents and medical students, and with a larger sample size. Additionally, future studies should include a more comprehensive assessment of neonatal care and evaluate the impact of using this app on the improvement of students' clinical performance through direct observation of caregiving skills.

Abbreviations

CI	Confidence interval
MD	Mean Difference
SD	Standard Deviation
WHO	World Health Organization

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Author contributions

The study conception and design were carried out by SGH, MMi, TS, MR, and SW. Data collection was performed by MMa and AN. The initial draft of the paper and the final manuscript were prepared by MMa and SGH. Data analysis was conducted by SGH and MMi. All authors have reviewed and approved the final manuscript for publication.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent of participants

The study protocol was approved by the ethics committee of Tabriz University of Medical Sciences, Tabriz, Iran (IR.TBZMED.REC.1401.050). In order to maintain the confidentiality of the information, the coding method of the questionnaire was used without mentioning the name and surname. Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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