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The Effect of App-based Versus Lecture-Based Education on Midwifery Students' Knowledge, Attitude, Satisfaction and Diagnostic Skills Regarding Newborn Screening for Congenital Hypothyroidism: A Quasi-Experimental Study

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ABSTRACT

Background & aim: The use of educational applications has increased in line with the growth in novel education methods. This study aimed to compare the effects of app-based versus lecture-based education on midwifery students' knowledge, attitudes, satisfaction and diagnostic skills regarding newborn screening for congenital hypothyroidism.

Methods: This study used a pre- and -test quasi-experimental design on Bachelor's degree in midwifery in Islamic Azad University of Mashhad in the 2023-2024 semester. The ScreenApp application was used as the intervention. Participants were randomly allocated to the Screen App, or lecture groups. The duration of the presentation was set at 30 minutes. All participants answered online questions on knowledge, attitudes, and skills through Google Forms at baseline and at the end of the intervention. The qustions were developed by the researcher, and the follow-up was immediate.

Results: Ninety-five participants with a mean age of 25.55 ± 8.16 years were included in the study. The increase in the mean knowledge score was not significantly different between the Screen App group (+3.31) and the lecture group (+2.40; P = 0.075). No significant between-group differences were also observed in attitude or skill scores (p > 0.05). However, students' satisfaction was significantly higher in the application group than in the lecture group (P = 0.001).

Conclusion: It appears that no single educational method has a definitive advantage over others, but given the level of acceptance of new educational methods by students, it is better to integrate educational application with traditional educational methods.

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Introduction

Education has undergone drastic changes due to the emergence of new methods, especially through smartphone applications. The lack of educational barriers and time limits for accessing

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materials; high flexibility, availability, and low cost are the most important advantages of electronic education, including smartphone educational applications (1). Teacher-centered educational methods have been a constant basis of education. However, as the educational target groups are mostly young individuals, whose lives are intertwined with smartphones, new educational methods have been hypothesized to improve educational outcomes, especially in specialized subjects (2).

Studies have shown that new educational methods have a significant role in increasing the quality of care, especially in midwifery (3). Because midwifery is a subgroup of medical sciences, students pass nearly equal proportions of theoretical and practical courses. Therefore, the strength of theoretical learning of midwifery students is linked to the effectiveness of diagnosis, management, and identification of high-risk cases in hospital practice (3).

Professional midwifery is prevention-oriented, and the knowledge and experience of midwives is reflected in the health status of the population. One of the complex and diverse issues in midwifery education is the interpretation and management of screening tests. Diversity, volume, and complexity in identifying and referring at-risk individuals reflect the level of responsibility and scope of the midwifery profession (4-5). Prenatal, newborn, and male screening tests are among the most important things that are taught in the curriculum of midwifery students. Screening tests are performed during pregnancy to identify fetal chromosomal disorders, while newborn screening tests focus on detecting thyroid disorders, phenylketonuria, and their management methods. Some of these tests require high accuracy and require to be stressed during education as neglecting these parameters can lead to nonreversible outcomes (6).

Newborn thyroid screening in the first days after birth is very important. Midwifery is a preventive-oriented profession that embodies the art, knowledge, and experience leading to the health of generations and communities. One of the complex and extensive topics in midwifery education is the training and management of the screening test. As thyroid disorders are among the most common newborn disorders in Iran, early detection of these disorders may prevent later mental retardation in children (7) .

Previous studies have demonstrated the growing role of mobile applications in nursing and midwifery education. Some studies deem the use of a smart application essential, while others continue to emphasize conventional methods; for example, Mohammadirizi et al. (2022) found no significant difference in student satisfaction between application-based and conventional clinical training (8). Seraj et al. (2022) reported positive effects of educational applications on clinical learning in their review study, although only five studies met their inclusion criteria (9). Similarly, Mohan et al. (2023) emphasized application usability and content quality (10). Kang et al. (2019) demonstrated the educational potential of video-based applications in breast examination training (11). Szaras et al. (2023) and Ryan et al (2024) also highlighted the contribution of digital technologies to professional learning. Overall, previous research indicates a need for more comprehensive intervention studies evaluating both educational effectiveness and user satisfaction (12-13).

Therefore, the present study was conducted with the aim of comparing the educational outcomes of thyroid screening test education between lectures and using the ISA application among midwifery students.

Materials and Methods

This study was a semi-experimental study that used pre-test and post-test method on 95 students of the 5th and 6th semesters of continuous bachelor's degree and the 1st and 2nd semesters of non-continuous bachelor's degree in midwifery in April 2024.

For the first time, an intelligent screening application (ISA), called "ScreenApp", was designed by the first author of this article. ISA is the first specialized system in the field of Obstetrics and Gynecology. Users can access the application either through the website or by running the application. The ISA website is designed with the latest technology of the Next.js 14 framework and is hosted on a Node is server. The design of the system is responsive and is suitable for all digital devices, including personal computers, Android phones, and iPhones.

The inclusion criteria included giving consent to participate in the study, being continuous midwifery students in the 5th or 6th semesters, or non-continuous midwifery students in the 2nd or 3rd semester ,lack of history of learning screening tests The exclusion criteria were failure to submit the questionnaire and history of taking the health and screenings courses.

Participants were assigned to two groups using simple random sampling. The educational content was based on the latest national guidelines and all resources included in the curriculum for the Bachelor of Midwifery program. The content were presented in the form of images and a self-directed learning process (with a green icon indicating approval and a red icon indicating rejection). The developed application was validated in terms of content and innovative educational aspects using factor analysis (14).

The duration of student access to the app was set at 30 minutes, and the duration of the educational session for the lecture group was also set at 30 minutes.

The application was designed using a framework, which supports search engine optimization features by default to improve the visibility in search results, and a server. The Node.js server creates a safe environment for users due to its asynchronous architecture and support for security modules. This platform has a special application design environment due to its unique features, including non-blocking input and output, simultaneous connections, rich ecosystem, and strong support. The Screen App application is of interest to most users due to its ease of implementation on Android phones due to the application of Java language, which is fast and compatible with most Android devices. All application content was designed in textual format based on the national protocols. The evaluation section was designed in the form of green (low-risk) and red (high-risk)icons.

The instruments used in this study were a demographic characteristics questionnaire, a researcher-made knowledge and attitude questionnaire, and the 5-item satisfaction questionnaire designed by Nickersonet al (2014) (5). Two abnormal neonatal thyroid tests were included in the tests to evaluate the diagnostic skills and the ability to correctly suggest the next management step. The overall number of questions was 38, which were provided to the participants through Google Form.

The knowledge domain of the Knowledge questionnaire included 12 yes/no questions about the etiology and epidemiology of hypothyroidism; and newborn thyroid screening methods, as well as the Thyroid Stimulating Hormone (TSH) level in newborn infants. Each correct answer was scored one and an incorrect answer was scored zero; therefore, higher scores indicated a higher knowledge level. The attitude questionnaire included 10 questions that were scored using a five-point Likert scale from strongly agree to strongly disagree and not have any opinion.



Figure 1. Application screenshot for thyroid screening

The content validity of the knowledge and attitude questionnaire was evaluated based on the opinions of 5 experts in the field of health screening (3 assistant professors and two senior expert academic staff). The Item Content Validity Index (I-CVI) was calculated as 0.92 for the total questionnaire (ranging between 0.77 and 0.95 for the questions), and the Scale Content Validity Index (S-CVI) was 0.93. The Content Validity Ratio (CVR) for the questionnaire was 0.92. The reliability of the questionnaire was evaluated through internal consistency (Cronbach's alpha was 0.77 for the total questionnaire, ranging between 0.72 and 0.78 for the questions).

The construct validity was also assessed. In this analysis, standard factor loadings were

examined, leading to the removal of questions 4,6,12 related to knowledge questions, as well as question 4 concerning attitude question The

remaining questions exhibited factor loadings over than 0.30, indicating an acceptable level of validity. In this analysis, the goodness-of-fit indices for the model were as follows:

RMSEA=0.06 ، IFI=0.91 ،CFI=0.91 ، $\frac{\chi^2}{df} = 1.37$

this suggests that the model fits well.

The educational content available in the Screen App application was prepared based on the latest national guidelines. Three members of the expert panel (two reproductive health specialists with working experience in health centers and a senior midwife with more than 10 years of educational experience) reviewed and approved the final revised content.

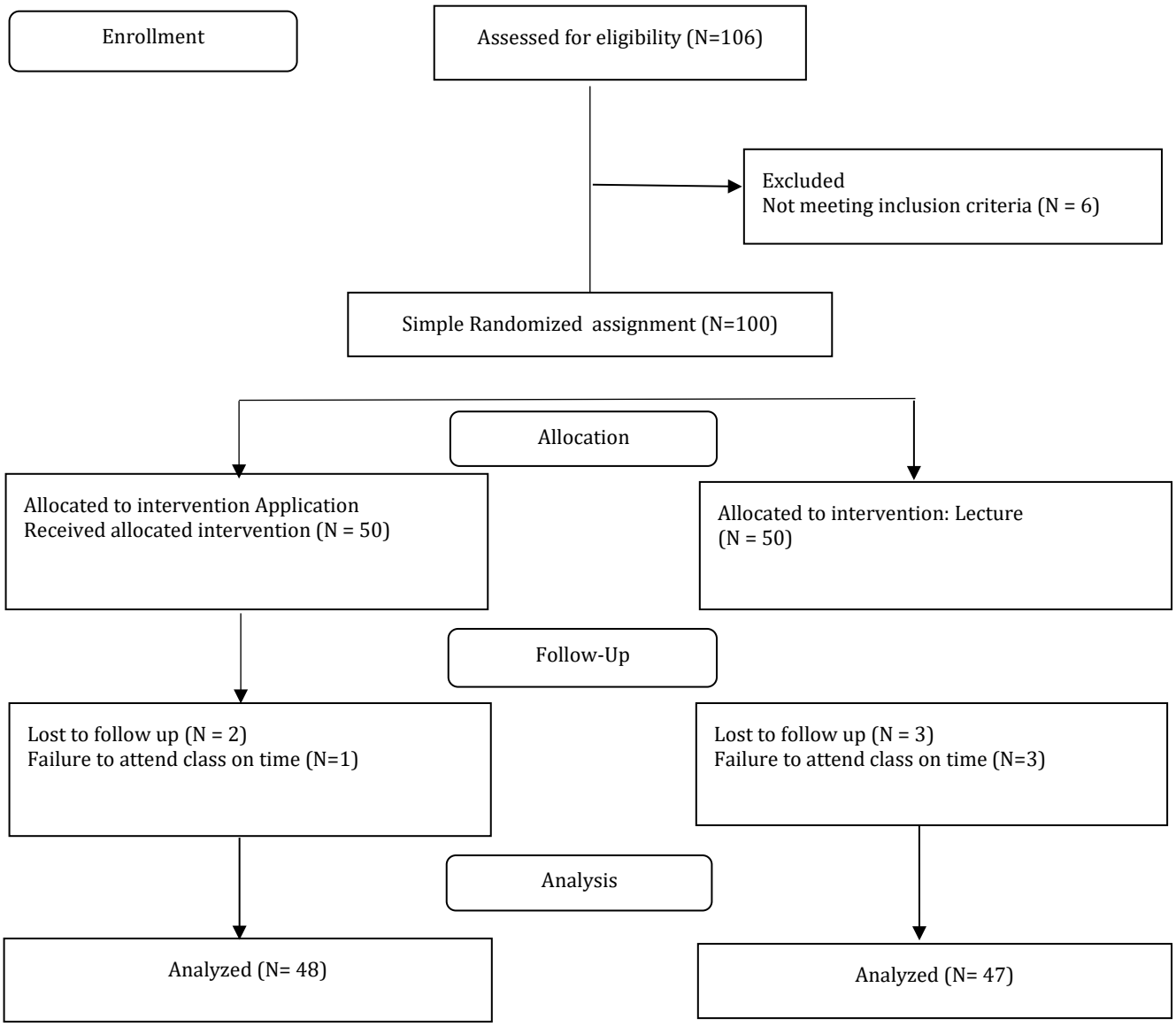


Figure 2. Trend Flowchart of the study

Before the intervention, the link to the checklist and the pre-test questionnaire was placed in the students' Telegram group. The pre-test questions were about the importance of thyroid screening, epidemiology of hypothyroidism in Iran, etiology of hypothyroidism, newborn hypothyroidism screening method, and TSH level interpretation in newborns. After filling the online questionnaire, participants were randomly allocated to either the lecture group or application group. Randomization was performed based on random block sampling (block size of four) and using the Seald envelope system. Participants were allocated into each of the application (A) and lecture (B) groups.

Participants in the lecture group received education on the principles of newborn thyroid screening by a lecturer with more than 8 years of teaching experience in the relevant subject. The lecture was provided using Power Point presentation for 15 minutes. Participants in the application group received the access link to the application through a Telegram channel created for this study (https://screenapp.liara.run/). The educational content in the lecture method was similar to that of the application method. The educational content for both groups was derived from similar sources and was based on the latest guidelines for newborn thyroid screening. It should be noted that the link to access the application was provided to the application group at the time of allocation. Two strategies were used to prevent access to the application by the control group. The first strategy was limiting the time to respond to the questionnaire, and the second strategy was active monitoring of the participants by the researchers while working with the application (Figure 2).

The Statistical Package for Social Sciences (SPSS) 26 software was used for statistical analysis. Continuous variables were described using mean and standard deviation (SD) and were compared using the Mann-Whitney or independent-samples t-test. Chi-square test was used to compare categorical variables between two groups. A general linear model was used to evaluate the effect of education method on knowledge and skills scores of the participants after controlling for confounders. The level of statistical significance was 0.05.

Results

Of the 106 individuals initially enrolled, 95 were included in the final analysis (Figure 2). The participants' mean age was 25.55 ± 8.16 years, ranging from 19 to 52 years. Comparison of the demographic characteristics of the study groups is shown in Table 1.

Table 1. Demographic characteristics of the app and lecture groups

Variable	Application group N=48	Lecture group N=47	t/Z/χ^2, P
Age (years)	28.3±10.1	22.9±4.6	Z=-1.92, P=0.055†
Number of children	0.63±1.16	0.17±1.39	Z=, P=0.013†
Type of education			
contentious	30(62.5%)	44(93.6%)	χ^2=13.54,
Non-contentious	18(37.5%)	3(6.4%)	P=0.001†
Marital status			
single	26(54.2%)	33(70.2%)	χ^2=2.60,
Married	22(45.8%)	14(29.8%)	P=0.107‡
Family history of neonatal hypothyroidisms			
Yes	1(2.1%)	1(2.1%)	χ^2=, P=0.99‡
No	46(97.9%)	46(97.9%)	
History of neonatal hypothyroidism in close relatives			
Yes	25(52.1%)	17(36.2%)	χ^2=2.44,
No	23(47.9%)	30(63.8%)	P=0.118‡
History of receiving education about neonatal hypothyroidism before entering university			

Yes	8(17.0%)	21(44.7%)	χ^2=8.43,
No	39(83.0%)	26(55.3%)	P=0.004‡

The data were described by Mean ± SD and N(%).† Mann-Whitney test, ‡chi-square test, Fisher's Exact test

There was no Significant difference in demographic characteristics such as age, marital status, family history of neonatal hypothyroidism, and history of neonatal hypothyroidisms in close relatives (P>0.05). However, the groups were not homogeneous in terms of the number of children and history of receiving education on thyroid screening tests before entering the study (Table 1).Comparison of the knowledge and skill scores between study groups is shown in Table 2. The improvement in knowledge was not significantly different among participants in the application group compared to the lecture group (P=0.075).

Table 2. Mean score of knowledge and skills before and after the intervention between the app and lecture groups

Variable	Application	Lecture	t/Z, P
Knowledge†			
Before	5.12±2.36	6.02±2.43	t=1.81, P=0.072
After	8.43±0.83	8.42±0.71	t=0.73, P=0.942
Difference	3.31±2.54	2.40±2.37	t=1.79, P=0.075
Skills†			
Before	0.48±0.58	0.74±0.74	Z=-1.75, P=0.081
After	0.83±0.78	0.83±0.67	Z=-0.10, P=0.923
Difference	0.09±1.03	0.36±0.93	Z=-1.19, P=0.233

† The Mann-Whitney test was used for the comparison. * Significant difference

There was no significant difference in skills scores between groups before and after intervention (P>0.05), and the change in skills scores was not significantly different between groups (P=0.233). However, the Wilcoxon test showed that the mean skills scores significantly increased in the application group (P=0.014), while the change in the lecture group was not statistically significant (P=0.588).

The analysis of Covariance was employed to control for confounding variables, particularly baseline values. The results are presented in Table 3.

Table 3. General linear model analysis of the effects of educational methods on knowledge and skills

Variable	B	Standard error	P
Knowledge			
Education method			
Application	0.039	0.167	0.818
Lecture	Reference	-	-
Knowledge score before education	0.03	0.035	0.391
Skills			
Education method			
Application	0.04	0.15	0.775
Lecture	Reference	-	-
Skills score before education	**-0.02**	0.11	0.87

* Controlled for age, Number of children, type of education, marital status, History of neonatal hypothyroidism in close relatives, and History of receiving education about neonatal hypothyroidism before entering university

The general linear model for the effect of education method on Knowledge and skills of the participants is presented in Table 3, after adjusting for baseline and confounders.

in close relatives, and History of receiving education about neonatal hypothyroidism before entering university .The general linear model for the effect of education method on Knowledge and skills of the participants is presented in Table 3, after adjusting for baseline and confounders.

There was no significant effect of education method on knowledge and skills scores of the participants (P=0.818) and (P=0.775) respectively (Table 3).

Since the demographic variables in Table 1 did not have a significant relationship with attitude and satisfaction, they were not considered as confounding variables. Therefore, comparison of attitude and satisfaction is presented in Table 4.

Table 4. Mean score of attitude and satisfaction scores in the app and lecture groups

Variable	Application	Lecture	P
Attitude†	32.31±4.03	30.95±4.37	0.186
Satisfaction‡	17.63±3.13	15.30±3.54	0.001

† The Mann-Whitney test was used for the comparison.
‡ The independent t-test was used for the comparison.

According to Table 4, there was no significant difference in attitude scores between groups (P=0.186), but the difference in satisfaction was greater in the application group compared to the lecture group (P=0.001).

Discussion

The aim of this study was to compare the knowledge, attitude, skills, and satisfaction of midwifery students regarding newborn thyroid screening test between lecture and application education methods. The knowledge score in the post-test was not significantly different between the application group and the lecture group. The study by Chung et al. (2018) reported that the level of knowledge was not significantly improved by using application compared to traditional education methods among Pediatric Intensive Care Unit residents (15). However, majority of previous studies indicated improvement in the level of knowledge, including a critical analysis study conducted on new educational methods like simulators, application training, and electronic training conducted in 2023 by Szara et al. indicated an increase in the knowledge of midwifery and nursing students with these new methods compared to traditional and common methods (12) .The systematic review study conducted by Pilabré et al. (2024)in South Africa also indicates an increase in the level of knowledge of learners using new educational methods, especially smartphone applications, due to ease of access by majority of the students (16) .But other studies in this field show that knowledge does not increase through the use of apps, or even an increased level of knowledge through this method can have a negative impact on education because most students view apps as entertainment and not a real educational space (17).

The results of this study indicated no significant difference in attitude scores between the application and lecture groups. A meta-analysis study conducted on 316 studies on educational applications by Chen et al. (2021) in China showed that students had positive attitudes toward using educational applications due to the increase in attitudinal thinking power. However, students tend to prefer learning non-virtually because it is possible that virtual learning is considered a leisure activity by students and thus distracts them(18) .One of the attitude questions in this study that might have caused the non-significant difference in attitude scores between groups was that the midwifery students in both groups stated that no method can replace the presence of the lecturer in the classroom because the lecturer's presence improved the understanding of the educational material. A meta-analysis conducted by Caskurl et al. (2020) indicated that face-to-face education in classes increased learning and student satisfaction and could be considered an important predictor for student learning outcomes (19).

After adjustment, although the mean skill score of the application group was 0.043 points higher than that of the lecture group.The study by Zakullah et al. (2023) on the diagnostic skill of radiographic images of Sudanese dental students was better among students who used an application compared to those who received

lecturer (20). The thematic analysis conducted by O'Connor et al. (2018) regarding the effect of using smartphones on students' skills indicated that using smartphone education improved practice through improving knowledge, reducing anxiety, and increasing self-confidence (21).

In this study, the type of study course (continuous and discontinuous students), study semester, the number of children, and receiving education about newborn thyroid screening before entering the university were significantly different between groups. Therefore, the effects of these confounders were adjusted using a general linear model. The model indicated a significantly higher satisfaction among participants in the application group compared to the lecture group (1.57 points difference) after adjustment for confounders.

The meta-analysis conducted by Chen et al. (2020) shows that the level of satisfaction of nursing students with education using the application method was higher than the lecture method (22). Also, the systematic review conducted by Pilabré et al. (2024) emphasized that satisfaction was higher among midwifery students who received training through the application method, especially in terms of learning psychomotor skills.(16) The previously stated reasons for the greater satisfaction in using application include ease of teaching, ease of learning, increased learning time, and easy access (23-24).

The level of knowledge, attitude, and skill was not significantly different between continuous and non-continuous bachelor students, while students in the application group had higher satisfaction level compared to the lecture group. To the best of our knowledge, none of the previously published studies evaluated satisfaction along with knowledge, attitude, and skills in one study.

In terms of the confounders, the results of previous studies were controversial. Duwal et al. (2020) showed that age, gender, and marital status had no effect on students' skills and performance (25). Also, the factor analysis study by Siahposht Khachaki et al. (2020) showed that individual characteristics of students had a moderate effect on their learning, and that the effect of other factors such as the educational environment, personal characteristics of the professor, and educational programs was higher than average (26). The umbrella meta-analysis by Tan et al. (2024) indicated that economic and social factors affect education outcomes, while among demographic variables, being married and having children did not affect education outcomes(23). This finding was also reported in other studies(22-23).

The findings of this study showed that receiving previous education on the subject significantly affected education outcomes. A review study conducted by Ssemugenyi et al. (2023) showed that students' previous experiences in the subject were the strongest predictor for educational outcomes (27). The meta-analysis conducted by Simonsmeier et al. (2022) in Germany showed that educational background and prior knowledge strongly influence educational outcomes (28). Based on the literature search in the available databases, among the variables mentioned in this study, only the educational background and socio-economic conditions affect the teaching results (29).

Various factors can affect the knowledge and awareness background of students before entering the university. Regarding newborn thyroid disorders, it can be pointed out that the prevalence of the disease is high in Iran. The meta-analysis by Afzali et al. (2023) determined that the prevalence of thyroid disorders in Iran is higher than in other Asian and American countries (2 in 1000 compared to 1 in 1000) (30) .Therefore, it is highly probable that the students were exposed to education on these disorders before entering university.

Education with any method can increase cognitive goals, so the results of this study do not conflict with the other studies (31).The study by Al-Hamad et al. (2023) showed that the level of knowledge and retention of scientific data among the third-year medical students were not significantly different between lecture and application methods. Therefore, the authors stated that no method is superior to another in this regard (32).

Although the results of this study showed that the level of satisfaction of the students in the application group was higher than the lecture group, and almost all existing studies show that educational applications can increase

knowledge, the educational results include not only the level of knowledge but also include identification and diagnosis of newborn thyroid disorders.

The presence of the lecturer and the lecture method may lead to a problem-solving process and interaction with the learners; therefore, lectures can create higher and better educational outcomes than other educational methods in the short term. Teaching through lectures in medical sciences is still highly preferred to other education methods because the interaction between the lecturer and the student is established at a high level, which is important in the learning procedure (33-35).

One of the advantages of this study was the use of the ScreenApp system, which is the only specialized system designed based on the validated Rogers' innovative theory (14). Among the independent variables in this study, only the type of study (continuous and non-continuous students) and having prior knowledge about newborn thyroid screening before entering university had an impact on the level of knowledge, attitude, skill and satisfaction of students. These two variables were not controllable and can be considered as limitations of the study. It is recommended that further studies evaluate the effect of new education technologies, including artificial intelligence, and use larger sample sizes. Further studies are needed to assess the long-term effects (more than one semester) of the education interventions.

Conclusion

This study showed that the use of ScreenApp in teaching newborn thyroid screening to midwifery students increased satisfaction to a greater extent compared to the lecturing method. But knowledge, attitude, and skill were not significantly different between the education methods.

The results of this study indicate that the use of modern educational methods can be applied to midwifery education, although the lecture method remains the preferred approach among students.

Declarations

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Conflicts of interest

The authors declared no conflicts of interest.

Ethical approval

The study received approval from the Ethics Committee of the Smart University of Medical Sciences (IR.SMUMS.REC.033), which was provided in the online questionnaire. All participants provided informed consent before participation in the study. Participants were free to leave the study at any time during the study procedure. Participants were assured of the confidentiality of their information.

Code of ethics

This study was part of a Master's thesis in medical education, which was approved by the Ethics Committee of the Smart University of Tehran (Code: IR.SMUMS.REC.1402.033).

Use of artificial intelligence (AI)

All aspects of the study design, implementation, and application development were carried out by the corresponding author and her coworkers. Artificial intelligence tools were used exclusively for English language editing and proofreading and were not involved in any other stage of the research, data analysis, or application development.

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Authors' contributions

TF and LM Study concept and design.TF and NA carried out the data collection. AJ and HS Analysis and interpretation of data; TF, SD drafting of the manuscript.; TF, SD, and LM critical revision of the manuscript for important intellectual content. All authors have reviewed and approved the final version of the manuscript.

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