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## Review

## Nursing students' attitudes toward mobile learning: An integrative review



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## ABSTRACT

**Purpose:** This study aimed to explore whether the attitudes of nursing students toward the use of mobile learning are positive or negative and to identify the factors influencing their attitudes by reviewing the literature.

**Methods:** Electronic search of six databases, including PubMed, the Cumulative Index of Nursing and Allied Health Literature, ProQuest, Web of Science, EMBASE, and Cochrane Library, was conducted, and relevant references within articles were manually searched. Retrieval time was from inception to October 21, 2020. The literature review was conducted in accordance with the PRISMA guidelines and the integrative review method. The Mixed Method Appraisal Tool (MMAT) was used for quality assessment.

**Results:** A total of 316 articles were identified, and 18 English-language studies were finally included by reviewing titles, abstracts, and full text. Six quantitative, five qualitative, and seven mixed-method articles related to nursing students' attitudes toward the use of mobile learning were identified. The results showed that most nursing students had positive attitudes toward mobile learning. Although students expressed strong intentions for mobile learning, the actual usage rate in practical settings was low. Several advantageous factors included usefulness, convenience, and ease of use, whereas disadvantageous factors included hardware facility, updated content, and software stability.

**Conclusion:** Most nursing students have positive attitudes and willingness to mobile learning, but the actual use rate remains low. Advantageous and disadvantageous factors coexist. Further studies are needed to assess how mobile learning improves nursing students' clinical knowledge and improves patient care.

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## What is known?

- Mobile learning is rapidly developing as an independent or supplementary method in nursing education. Mobile learning has a positive effect on the classroom learning of nursing students. However, there are some controversies in existing research about nursing students' attitudes towards mobile learning.

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## What is new?

- In clinical nursing education, mobile learning can improve the skills, knowledge and confidence of nursing students. Nursing students show positive attitudes to mobile learning. Facilitating factors to use mobile learning include its usefulness, convenience, and ease of use, whereas barriers include limitations of hardware facility, updated content, and software stability.
- Mobile learning may be a dominant or supplementary teaching method in clinical nursing education.

## 1. Introduction

Nursing students must master adequate theoretical knowledge and clinical skills during their nursing studies [1]. With sufficient knowledge and experience, they can properly care for patients [2], and at the same time, ensure patient safety and satisfaction [3]. With the rapid development of nursing courses, learning materials, such as videos and web pages, have become more diversified, replacing words and images in textbooks [4]. Recently, nursing students have shown great interest in personalized learning, which means they are no longer satisfied with traditional classroom learning; instead, they study at their own pace with no restraint on time and space [5]. For these reasons, traditional teaching and learning methods are not in line with modern nursing learning [6]. Therefore, new educational methods must be identified and introduced to improve the knowledge, skills and patient care of nursing students.

Mobile learning is a self-directed learning method that allows students to access related information repeatedly with no restraint on time and space [5]. It is defined as studying that occurs anytime and anywhere with the help of mobile devices [7]. Mobile learning is composed of three components: mobile devices (e.g., smartphone, personal digital assistant, tablet computer), applications (e.g., mobile apps for nursing education, learning management system), and internet service (e.g., Telstra, AT&T) [8]. The rapid development of mobile learning is affecting all aspects of schooling [9] and becoming increasingly popular with nursing students [10,11]. A previous study reported that mobile learning now serves as a supplementary method for nursing students in several areas of nursing education [6]. A meta-analysis also revealed that mobile learning could improve the knowledge, skills, and confidence of nursing students [12].

Mobile learning plays an active role in promoting the learning of nursing students. Compared with traditional learning methods, this new learning approach meets the requirements of nursing education in new areas by virtue of its advantages and learning outcomes. Especially in the period of the global COVID-19 pandemic, nursing students, similar to other students, are isolated at home [13]. This situation leads to a paradigm shift from face-to-face to online teaching and learning [14]. Mobile learning provides an effective study platform for nursing students during this pandemic crisis [15].

While nursing students' attitudes toward mobile learning have already been explored, they have not been synthesized, even though the students can benefit greatly from this new learning approach. There is great significance in studying the attitudes of nursing students toward mobile learning. We can fully understand the real attitude of nursing students towards mobile learning, as well as learn about the obstacles that affect the use of mobile learning and the factors that promote mobile learning. This knowledge will in turn provide a reference for further promoting the application of mobile learning in the learning of nursing students [16]. However, there are some controversies in existing

research. Some studies indicated that students have positive attitudes [17,18], whereas another study revealed that students are indecisive on whether mobile learning has obvious advantages or disadvantages [16]. The integrative review was undertaken to determine if nursing students' attitudes toward mobile learning are positive or negative and identify the factors influencing their attitudes.

## 2. Methods

### 2.1. Study design

A literature review was conducted in accordance with the PRISMA guidelines [19] and the integrative review method described by Whittemore and Knafelz [20]. The integrative approach used in this literature review allowed us to provide a qualitative synthesis of the selected studies. Such integrative review study enabled the observation of nursing students' attitudes and the influencing factors on their attitudes toward mobile learning. The finding could provide a theoretical basis for applying mobile learning in nursing education in the future.

### 2.2. Search strategy

Six databases, including PubMed, the Cumulative Index of Nursing and Allied Health Literature (CINAHL), ProQuest, Web of Science, EMBASE, and Cochrane Library, were electronically searched from the inception of each database to October 21, 2020. A search strategy combining subject terms and free words was developed, including *nurs\**, *student*, *undergraduate*, *attitude*, *perception*, *mobile learning*, *m-learning*, and *mobile application*, and possible synonyms were also used. The PubMed search strategy is shown in Appendix A. The references in each study were manually retrieved. Articles searched were uploaded to EndNote X9 for further screening based on the inclusive and exclusive criteria.

The inclusion criteria included 1) research related to the attitudes of nursing students toward mobile learning and/or factors influencing their attitudes, 2) English language, 3) studies published in peer-reviewed journals, 4) original articles, and 5) nursing students at any year of education enrolled as participants.

The exclusion criteria included 1) editorials, reviews, repeated articles, and conference articles, and 2) unable to obtain the original data even by contacting the authors.

### 2.3. Data extraction

Data were extracted from the selected studies and entered separately into a pre-fabricated form by two reviewers. Any discrepancy was resolved by reviewing and discussing the full text. The information displayed on the form included first author, year, location, aims, design, samples, methods, data analysis, and outcomes.

### 2.4. Quality assessments

Quality assessments of the included studies were performed using the Mixed Method Appraisal Tool (MMAT) [21]. Since all the included studies were published in peer-reviewed journals and subjected to blind review, no study was excluded. The assessments were independently performed by two reviewers, and any disagreement was solved during consensus.

### 2.5. Data analysis and synthesis

The enrolled students and the explanations obtained from

qualitative research were quoted and used for data analysis. The author's information of the studies was also considered for meaningful discussion and explanation. The selected articles were read, and the data were coded independently until the final themes were identified. Initial themes were refined until the final themes emerged. Data analysis and synthesis of the included studies were independently performed by two reviewers, and any disagreement was solved during consensus.

### 3. Results

#### 3.1. Search results

The title and abstract (if necessary, the full-text) of each article were reviewed to determine if data on nursing students' attitudes toward mobile learning were contained in the studies. A total of 316 articles were identified from PubMed ( $n = 118$ ), CINAHL ( $n = 57$ ), ProQuest ( $n = 15$ ), Web of Science ( $n = 39$ ), EMBASE ( $n = 27$ ), Cochrane Library ( $n = 50$ ), and 10 additional articles were obtained by a manual search of relevant references in these articles. Thirty-four duplicates were excluded. Following a review of the title and abstract, 203 articles were further excluded, including 75 that were not pertinent to nursing students, 116 that were not pertinent to mobile learning, nine that were review articles, and three that were not presented in English. Of the remaining 79 articles, two were further excluded due to the unavailability of full-text, and 59 were finally removed after full-text screening, including 17 that were not relevant to the research topic, 29 that enrolled individuals other than nursing students, three that were not original articles, and ten that were repetitive publications. Eventually, 18 articles were included in this review study, including six quantitative, five qualitative, seven mixed-method articles. The screening and exclusion processes are shown in Fig. 1.

#### 3.2. Study characteristics

In the 18 included studies, six were quantitative studies that used a cross-sectional, descriptive/correlational design [16–18,22–24]. No study used a two-group descriptive comparative design or longitudinal, pre-test/post-test design. All six studies used self-reported questionnaires to collect data on nursing

students' attitudes toward mobile learning. For instance, Sheikhtaheri et al. [17] assessed the views of nursing students on the benefits of using mobile technology in education.

The five qualitative studies included in this analysis used a longitudinal, one-group design [25–29]. For example, Hsu et al. [25] used in-depth interviews to examine the thoughts and experiences of nursing students who received a smartphone with an app-based physical assessment educational intervention. Data were collected using in-depth interviews and analyzed using a thematic coding method, which incorporated systematic analyses of the transcribed data.

The remaining seven studies utilized mixed-methods, with four studies using a cross-sectional, descriptive design [30–33] and three using a longitudinal, one-group, pre-test/post-test design [34–36]. Three questionnaires were prepared by researchers, and the other three were based on the existing scale or an earlier questionnaire. For example, Mather and Cummings [30] conducted an online survey comprising of the study group, whereas Lai and Wu [35] used a professional competency scale developed based on Rong and Laiu's [37] "competence and credentialing model of community psychiatric mental health nursing." Four studies used open-ended questions, one used an in-depth interview, and one used a focus group.

Three studies proposed a theoretical framework [16,22,33], with one [16] selecting the Technology Acceptance Model (TAM), one [22] expanding the Diffusion of Innovations Theory, and one [33] using Kearsley and Shneiderman's Framework for Technology Based Teaching and Learning. TAM is the most widely studied model for the adoption of information technology to identify the comprehensive set of determinants of adoption and address the role of supporting the adoption and use of innovative interventions. The Diffusion of Innovations Theory uses social media and mobile technology to identify knowledge, attitudes, and practices that can help improve the contemporary abilities of college students.

The participants in 18 studies were all undergraduate nursing students, while one involved both undergraduate and graduate students [28]. Six were in their senior (third or fourth) year [17,18,23,24,26,31], 11 from each year of the whole grade [11,16,22,25,27–30,32–34], and one in the second year of a two-year continuing education program [35]. Sample sizes varied from as small as 8 to as large as 387, but two studies did not provide a

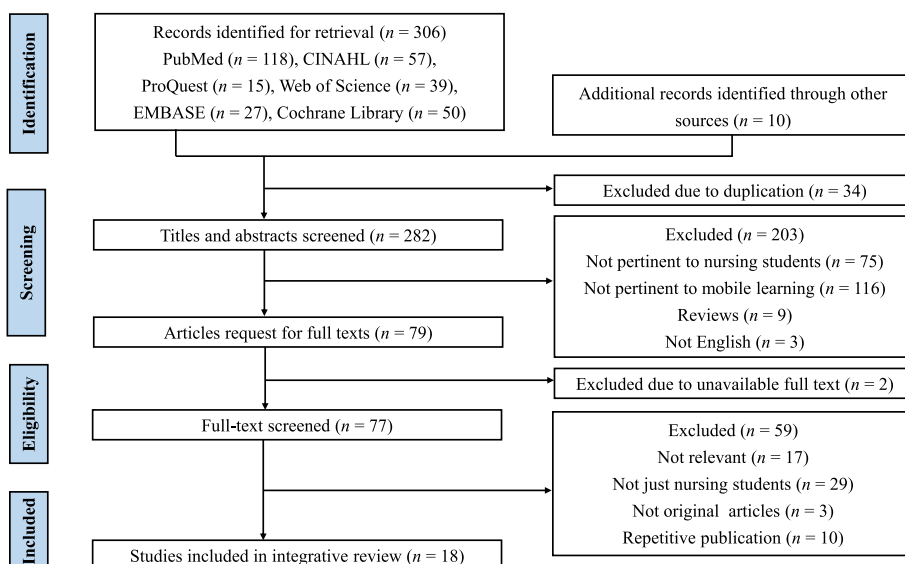


Fig. 1. Flow diagram of the literature search and selection process.

sample size [29,30]. Most of the participants were female, and the participants in one study [35] were all female. Three studies were conducted in multi-centers [17,24,32], and the remaining were conducted in single centers.

Several questionnaires were used in the included studies, and each one had adequate reliability and validity (Cronbach's  $\alpha$  coefficient  $\geq 0.7$ ). Two surveys were prepared on the basis of the conceptual frameworks. Zayim and Ozel [16] established the m-learning opinion scale based on the TAM model, which consisted of five subscales that use five-point Likert scale scoring. Hay et al.'s [22] 26-item questionnaire was generated on the basis of the Diffusion of Innovations Theory, and used four-point Likert scale scoring. The remaining three questionnaires were developed using published research findings. Wu and Sung's [31] survey design was based on the questionnaire developed by Chen [38], and used a 5-point Likert scale. It was revised by two experts to ensure good internal consistency coefficient and construct validity. Six questionnaires were developed by the researchers themselves, and one did not provide details on the contents of the survey. Tables 1–3 shows the study characteristics, and Table 4 presents the study quality.

### 3.3. Major findings

#### 3.3.1. Attitudes toward mobile learning

By and large, most nursing students had positive attitudes toward mobile learning. Mobile learning has become one of the priorities for nursing students. For example, Lai and Wu [35] reported that a large proportion of students showed significantly high enthusiasm when using the mobile learning system, though there were some technical difficulties and stress.

**Table 1**  
Characteristics of quantitative studies included in this review.

Author, year, Location	Study aim	Sample size	Methods and data analysis	Outcome
Wu et al., 2011 [18] Taiwan, China	To investigate students' views on the training program and mobile learning.	25 fourth-year nursing students	Questionnaire study, one-sample <i>t</i> -test	Students scored the ease of use and useful of the system positively.
Sheikhtaheri et al., 2018 [17] Iran	To investigate students' views on the benefits of mobile learning.	170 student nurses	Questionnaire study, one-sample <i>t</i> -test	Students believed the main advantages of mobile apps were that improved student quality, quality of care, and faster access to information.
Zayim et al., 2015 [16] Turkey	To investigate students' views on mobile learning environments and readiness of using mobile learning.	387 nursing students	Questionnaire study, Pearson $\chi^2$ test, $\chi^2$ test, and Spearman correlation test, Independent-samples <i>t</i> -test, logistic regression method	<ol style="list-style-type: none"> <li>1 Students in higher classes were more inclined to favor mobile phones compared with laptops.</li> <li>2 Females and senior classes generally considered potential use areas of m-learning more practical.</li> <li>3 The common problems were hardware quality (battery life) and financial constraints (high cost of communication).</li> <li>4 Approximately 50% of students were ready for mobile learning, whereas approximately 25% of students were undecided.</li> </ol>
Hay et al., 2016 [22] Australia	To investigate how social media and mobile devices assist with learning.	386 undergraduate nursing students	Questionnaire study, separate ANOVA	Students were more supportive of social media and mobile technology in principle than in practice.
Pimmer et al., 2018 [24] Nigeria	To investigate the correlations between WhatsApp use and socio-professional indicators.	196 final-year nursing students	Questionnaire study, method of data analysis not mentioned	<ol style="list-style-type: none"> <li>1 Students perceived platform strongly enhanced their communication with other students and nurses.</li> <li>2 Factors: positively associated with students' maintained social capital with peer students, the development of a professional identity, placement satisfaction and with reduced feelings of isolation from professional communities.</li> </ol>
Ortega et al., 2010 [23] Spain	To investigate students' views on mobile learning.	28 third-year nursing students	Questionnaire study, descriptive statistics	Students showed positive views (i.e., toward learning thought it easy to use, useful, time saving and worthwhile.

#### 3.3.2. Advantageous factors affecting attitudes toward mobile learning

The 18 included studies uncovered several advantageous factors that affected nursing students' attitudes toward mobile learning, including usefulness, convenience, and ease of use.

The most favorable factor was the usefulness of mobile learning. Eleven articles [16–18,23,25,27,29,31–34] showed that students believed mobile learning was beneficial to both themselves and their studies. After the mobile learning intervention, some students stated that mobile learning was an effective learning aid to stimulate thinking [25], increase self-confidence [31,32], improve knowledge [17,25,31,32,34], and reduce the degrees of stress and anxiety associated with studying [31,32].

The second most helpful factor was the convenience of mobile learning devices. Nine studies [17,23–25,29–32,34] demonstrated that nursing students believed mobile learning devices were convenient. Participants in several studies stated that mobile devices could instantly connect to the Internet and obtain the required sources [17,30,32,34]. Mobile devices, such as iPhones or iPads, allowed students to quickly contact their classmates and ask questions [24,25,30] and, if needed, contact tutors and receive a timely response [25,31].

Some references emphasized the ease of utilizing the mobile learning system. Four studies [11,18,23,31] addressed students' perceptions on ease of use. The participants also stated that mobile devices were great tools that were easy to use.

#### 3.3.3. Disadvantageous factors affecting attitudes toward mobile learning

Seven studies [16,25,27,28,30,32,36] identified several disadvantageous factors that affected the attitudes of nursing students toward mobile learning. Students stated that there were

**Table 2**  
Characteristics of qualitative studies included in this review.

Author, year, Location	Study aim	Sample size	Methods and data analysis	Outcome
Hsu et al., 2018 [25] Taiwan, China	To investigate the views of students who received smartphones with an installed app for mobile learning.	16 nursing students	In-depth interviews, followed by thematic coding	1 Mobile app promoted transferability of the nursing students' knowledge and past experience. With the help of the app, teachers could offer timely guidance to the students. 2 Five themes of the study were as follow: App's physical assessment scenarios are very close to real-life clinical situations; Watching physical assessment videos over the app is a quick way to learn what to do; App is a new way of learning; Some nursing students felt it was out of their depth to analyze the scenarios in the app; App needs enhancements in stability and interactivity.
Wu, 2014 [26] Taiwan, China	To investigate students' views on mobile learning.	36 fourth-year nursing students	In-depth interviews, followed by thematic coding	Students showed positive attitudes toward mobile learning
Willemse, 2014 [27] South Africa	To investigate students' views on WhatsApp use.	21 undergraduate nursing students	In-depth interviews, followed by thematic coding	Seven themes were identified that included: Positive experiences using the WhatsApp; Usefulness; The availability of resources for test preparation; Opportunity for clarification; Anonymity; Exclusion of students as a result of the lack of an appropriate device; Short battery life.
Beauregard et al., 2017 [28] USA	To explore nursing students' perceptions of using smartphones.	8 undergraduate and graduate nursing students	Individual semi-structured interviews. An inductive approach described by Elo and Kyngäs was used for data analysis	Students describe unclear expectations regarding the use of smartphones that force them to adopt individualized strategies to maintain their professional image and avoid negative consequences
George et al., 2017 [29] USA	To evaluate the students' experience of implementing point-of-care (POC) smartphone applications.	pre-licensure first-semester nursing students (sample size not provided)	Open-ended survey questions	Students feel that the smartphone app is useful and convenient.

disadvantages such as hardware issues, updated content, and software stability.

Some students complained about the hardware quality, such as the short battery life and the inability to charge anytime and anywhere, in addition to the small screen size that produced unclear text and images [16,27,30]. Furthermore, several nursing students were skeptical about the update speed of critical resources [30,32]. Other problems included mobile devices' stability, such as the slow connection to the content in demand and the repeated application flashback [23,25,30,32]. Others stated concerns about high monthly communication fees and the ease of losing devices [16,30].

### 3.3.4. Intention of students for mobile learning

Seven studies [22,23,26,31,33–35] demonstrated that most nursing students had strong intentions of using mobile learning as a method to improve studying. The students believed that mobile learning improved the learning process. In a study by Ortega et al. [23], 86% of students believed mobile learning enriched their learning, whereas 95% regarded it as a valuable tool. Indeed, 94% of students had strong intentions of using mobile learning and recommending its use in other courses. Although there was a high need for mobile learning among nursing students, the actual usage rate of mobile learning in practical settings was low [32].

## 4. Discussion

At present, the crisis caused by the global COVID-19 pandemic has suspended almost all activities, which brings many challenges to nursing students [39]. For many nursing students, mobile technology is the only way they can stick to their courses, all of which were almost online during the COVID-19 pandemic [40]. A number of the latest research results showed that mobile learning could

help nursing students improve their learning in this special period. The most frequently highlighted features are as follows: easy access to educational resources, unlimited membership, all forms and scales of tools for uploading or downloading files, the promotion of well-being, and safe [15,41,42].

Generally speaking, there is not much research on nursing students' attitudes toward mobile learning. However, in the past decade or so, this area of learning has expanded [43]. This may be due to the fact that mobile learning originated in the 1990s and developed rapidly after the 2000s, but it has only been used in the field of nursing education in recent years [44]. Most of the included studies have several limitations or characteristics in study design, such as adopting a one-group design and convenience sampling. Only four articles involved multi-centers, while others involved single-centers. Furthermore, only two studies selected a theoretical framework, whereas most studies lacked a statement of theoretical support. These limitations may have contributed to the deviation of results, and thus, data should be interpreted with caution. The geographical distribution of included studies indicates that mobile learning is of worldwide concern, and nursing students from all over the world showed a strong desire to use mobile learning. Research questionnaires in five studies [16,22,24,31,35] were generated on the basis of the existing theory or directly adopted to the present scale. One [11] study did not support the original data, and the remaining used self-prepared scales. Although self-prepared scales showed adequate reliability and validity, we need to be cautious when arriving at conclusions. At this point, more universal scales are needed to facilitate data interpretation.

This study revealed that most nursing students have positive attitudes toward mobile learning, a finding that is consistent with previous studies [16,32]. This is because of the advantages of mobile learning, including learning on demand that is not limited by

**Table 3**  
Characteristics of mixed methods studies included in this review.

Author, year, Location	Study aim	Sample size	Methods and data analysis	Outcome
Mather et al., 2016 [30] Australia	To investigate the use of mobile learning by undergraduate student nurses revealed barriers, challenges, risks, and benefits to using mobile learning at the workplace.	Undergraduate nurses (sample size not provided)	Online survey study and guided questions, method of quantity data analysis was not stated, thematic coding.	<ol style="list-style-type: none"> <li>1 Students indicated use of mobile devices easier access to resource and useful for communication.</li> <li>2 Students indicated mobile devices facilitated efficient and effective time management that positively impact on learning opportunities.</li> <li>3 Student comments focused on “battery life, screen size”, “availability of charging ports”, “speed of the Internet” or devices loaded with resources “may not be regularly updated”.</li> <li>4 Theft or loss of the device.</li> <li>5 Students also concerned it may look unprofessional to be seen using mobile technology as it may not be assumed it is being used for educational purposes.</li> </ol>
Burke et al., 2014 [34] USA	To investigate students' views on podcast materials.	87 nursing students	Questionnaire study and open-ended questions, method of quantity data analysis was not stated, thematic coding.	Students believed podcasts enriched their learning, and reported podcasts as valuable tools in the learning environment. Most students would recommend podcasting in other courses.
Lai et al., 2016 [35] Taiwan, China	To investigate the benefits of using the mobile e-portfolio-based system.	10 s-year nursing students	Questionnaire study and open-ended questions, content analysis method	<ol style="list-style-type: none"> <li>1 Students displayed very positive attitudes overall when using the system.</li> <li>2 There were some occasional stresses and technical difficulties including: adopting the proper mobile device, providing students with clear guidance on constructing the e-portfolio, and how to use the e-portfolio in a clinical setting.</li> </ol>
Wu et al., 2014 [31] Taiwan, China	To investigate the benefits of using mobile devices and cloud learning.	68 fourth-year nursing students	Questionnaire study and in-depth interviews, $\chi^2$ test.	<ol style="list-style-type: none"> <li>1 Most students expressed a positive attitude toward and were satisfied with the innovative learning method. They thought it was useful and convenient, enhanced the students' memory, reduced learning stress, and increased their confidence in using professional skills.</li> <li>2 Students recognized four characteristics of the learning environment, which were convenience, immediacy, interactivity, and assistance</li> </ol>
O'Connor et al., 2018 [32] Ireland	To investigate students' views on the use of smartphones with an installed app.	200 undergraduate nursing students	Questionnaire study and open-ended questions, descriptive statistics, thematic analysis.	<ol style="list-style-type: none"> <li>1 Fewer than half of 200 students used mobile apps to help them learn in clinical practice.</li> <li>2 Calculators, drug reference guides and medical dictionaries were used with varying frequency.</li> <li>3 Students reported numerous benefits of mobile technology such as better access to educational material, improvements in knowledge and confidence, and reduced levels of anxiety.</li> <li>4 Barriers such as negative attitudes of nursing staff, poor Wi-Fi connectivity, and the quality of educational content available on mobile apps.</li> </ol>
Dearnley et al., 2008 [36] United Kingdom	To investigate the feasibility.	24 midwife students	Questionnaire study and group focus, descriptive statistics, QRS software for qualitative data analysis.	<ol style="list-style-type: none"> <li>1 Students liked the convenience of the Pocket PC but disliked its reliability.</li> <li>2 Students were anxious about the reliability of the device and the possibility of losing assessment data.</li> </ol>
Gallegos et al., 2019 [33] USA	To describe students' perceptions of engagement and learning using a mobile device	59 undergraduate baccalaureate nursing students	Online survey study and oral interviews, analyzed using conventional content analysis.	<ol style="list-style-type: none"> <li>1 Students reported a positive experience.</li> <li>2 Students benefited from thoughtful, intentional mobile device use that engaged them with course ideas, limited off-task distractions, and improved collaborative experiences with peers and the instructor.</li> </ol>

place and time, fast, accurate, and accessibility to the latest information. Motivation for autonomous learning and effective communication between teachers and students were all effectively improved. Practicality and ease of cleaning/disinfection increase these preferences [16]. Almost all the students thought that mobile learning facilitated their nursing studies. Their progress in theoretical and clinical competence was also indicative of this finding. The students gained more confidence as they used the mobile learning methods [39]. Owing to their mobility, students could use mobile devices to collect and access data anytime and anywhere. In addition, they could get timely feedback from teachers, refer to

other's homework and check their progress so as to manage their own learning. Students were also more motivated to learn in the mobile learning environment and more willing to standardize their learning.

The results showed positive influence factors on mobile learning, including usefulness, convenience, and ease of use, which are consistent with previous studies [1,5]. This may be because mobile devices, such as smartphones, support a self-learning environment, which means that students can learn anytime and anywhere. With mobile learning, students can accept more learning opportunities that one-time lectures can not promote [45].

**Table 4**  
Quality check within MMAT.

Study design	Methodological quality criteria	Study	Yes	No	Can't tell	Comments
Quantitative	①Is the sampling strategy relevant to address the research question? ②Is the sample representative of the target population? ③Are the measurements appropriate? ④Is the risk of nonresponse bias low? ⑤Is the statistical analysis appropriate to answer the research question?	Wu et al., 2011 [18]	①②③④⑤			
		Sheikhtaheri et al., 2018 [17]	①②③④⑤			
		Zayim et al., 2015 [16]	①②③④⑤			
		Hay et al., 2017 [22]	①②③④⑤			
		Pimmer et al., 2018 [24]	①②③④	⑤	Method of data analysis not mentioned.	
Qualitative	①Is the qualitative approach appropriate to answer the research question? ②Are the qualitative data collection methods adequate to address the research question? ③Are the findings adequately derived from the data? ④Is the interpretation of results sufficiently substantiated by data? ⑤Is there coherence between qualitative data sources, collection, analysis and interpretation?	Ortega et al., 2010 [23]	①②③④⑤			
		Hsu et al., 2018 [25]	①②③④	⑤	Method of data analysis was not stated.	
		Wu, 2014 [26]	①②③④⑤			
		Willemse, 2014 [27]	①②③④⑤			
		Beaugard et al., 2017 [28]	①②③④⑤			
Mixed methods	①Is there an adequate rationale for using a mixed methods design to address the research question? ②Are the different components of the study effectively integrated to answer the research question? ③Are the outputs of the integration of qualitative and quantitative components adequately interpreted? ④Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? ⑤Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	George et al., 2017 [29]	①②③④	⑤	Method of data analysis was not stated.	
		Mather et al., 2016 [30]	①②③④	⑤	Method of data analysis was not stated.	
		Burke et al., 2014 [34]	①②③④	⑤	Method of data analysis was not stated.	
		Lai et al., 2016 [35]	①②③④⑤			
		Wu et al., 2014 [31]	①②③④⑤			
		O'Connor et al., 2018 [32]	①②③④⑤			
		Dearnley et al., 2008 [36]	①②③④⑤			
Gallegos et al., 2019 [33]	①②③④⑤					

Note: MMAT = Mixed Method Appraisal Tool.

Another advantage is the ability to connect instantly to other people. Thus, mobile learning enhances communication with the public to obtain useful information anytime and anywhere. The most important advantage is its ability not to impose learning restrictions regard to time and space. Furthermore, students agreed with the ease of use of mobile learning, consistent with previous studies [18,46]. Mobile devices, such as smartphones, are popular among students [47], and nursing students use them for more than 2 h a day [25]. In this setting, students could operate mobile phones and use the applications expertly and easily. These advantages are important in improving mobile learning and should be made full use of to serve nursing students.

Meanwhile, the study also represented some adverse factors, including hardware facility, updated content, and software stability, all of which correspond with previous research [30,32]. Despite the many advantages of mobile learning, there were also several complaints with regard to some objective reasons that are difficult to solve at present [16,30]. These problems seriously hinder the promotion and application of mobile learning, which we should focus on solving. Manufacturers of mobile devices should concentrate on hardware issues, such as battery capacity and charging, and organizations involved should update and validate educational resources. At this point, further studies are needed to resolve the misgivings of students and utilize mobile learning more preferably.

Indeed, this study also showed that students expressed strong intentions of mobile learning, but the actual utilization rate is low. This finding is consistent with that of a previous study [23]. A possible reason for this is that the use of mobile learning does not reflect the actual learning situation [32]. Moreover, we are used to using smartphones for entertainment but ignore their learning function [48]. To these points, we suggest drawing the whole social group's awareness of using mobile learning to help students' daily

study. In addition, more useful research should be conducted, and the results should be transferred to the actual learning environment.

### 5. Strengths and limitations

Our study has several strengths. First, as far as we know, this is the first integrative review to assess the attitudes of nursing students toward mobile learning. We discussed the main attitudes of nursing students, as well as the advantageous and disadvantageous factors that influence the attitudes and intentions of mobile learning. Second, we adopted the updated integrative review method of Whittemore and KnafI to guarantee the preciseness of this review.

However, this study also had several limitations. Firstly, database searches were limited to PubMed, CINAHL, ProQuest, Web of Science, EMBASE, and Cochrane Library. Secondly, we restricted the language to English. Thus, it is possible that some studies on nursing students' attitudes toward mobile learning were not included in this article, and this may have resulted in a bias of the ultimate outcome. Future studies or literature reviews should consider the influence of gender bias and attempt to equalize male and female participants.

### 6. Conclusion

This review aimed to investigate nursing students' attitudes toward mobile learning and factors affecting their attitudes. This study showed that most nursing students had positive attitudes toward mobile learning. Although students expressed strong intentions for mobile learning, the actual usage rate in practical settings was low. Several advantageous factors included usefulness,

convenience, and ease of use, whereas disadvantageous factors included hardware facility, updated content, and software stability. Due to the limited number of included articles, further high-quality studies, such as those using a two-group experiment design and general questionnaires, as well as those supported by a theoretical framework, are needed to confirm our findings.

### CRediT authorship contribution statement

**Bin Chen:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Project administration. **Ting Yang:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Project administration. **Yan Wang:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Supervision, Project administration. **Lei Xiao:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing, Supervision, Project administration. **Changxia Xu:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing. **Yuan Shen:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing. **Qin Qin:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing. **Yuanyuan Wang:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – review & editing. **Cheng Li:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – review & editing. **Fengqin Chen:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Yufei Leng:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Yalou Pu:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Zhilong Sun:** Conceptualization, Methodology, Validation, Formal analysis, Funding acquisition, Writing – review & editing, Supervision, Project administration.

### Declaration of competing interest

The authors declare that there is no conflict of interests.

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### Data availability statement

Authors declare the absence of shared data in the present study.

### Appendices. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijnss.2021.08.004>.

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