



## Research article

# The effect of the case-based learning approach on the level of satisfactions and learning of nursing students in Iran: A randomized controlled trial

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## ABSTRACT

**Introduction:** Nurses must have sufficient knowledge and skills in the field of medications and medication management. This study was designed to investigate the effect of the case-based learning (CBL) approach on the level of satisfaction and learning of nursing students.

**Materials and methods:** This study was conducted using a randomized controlled trial on 70 Iranian third-semester nursing students during a pharmacology internship in 2023. After considering the inclusion criteria, the samples were entered into the study by census method and then they were placed in either the control (35 people) or intervention (35 people) groups by simple random method. Pharmacology training was done in the control group by the usual method (lectures by the instructor and conferences with students) and in the intervention group by the Kaddoura case-based learning method. Data collection tools included a demographic questionnaire, satisfaction of educational approach questionnaire, and exam scores before and after the internship. SPSS version 26 software was used for statistical analysis.

**Results:** There was no statistically significant difference ( $P = 0.88$ ) in the mean scores of the pharmacology pre-test in the control ( $10.54 \pm 2.74$ ) and intervention groups ( $10.6 \pm 3.49$ ) before the intervention. Also, there was no statistically significant difference ( $P = 0.19$ ) between the pharmacology post-test scores in the control ( $17.7 \pm 1.15$ ) and intervention groups ( $18.07 \pm 0.91$ ). A comparison of pre-test and post-test scores in both control and intervention groups showed that the post-test scores in both groups increased significantly ( $P < 0.001$ ). The results showed that the intervention group was significantly ( $P = 0.008$ ) more satisfied with the learning method.

**Conclusion:** The case-based educational approach resulted in improved satisfaction among students in the pharmacology course. It is recommended to incorporate this learning method alongside traditional teaching methods, in nursing education, particularly in pharmacology instruction.

## 1. Introduction

Medication management is a critical component of nursing practice, as nurses play a vital role in ensuring the safe and effective use

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of medications for their patients [1]. Nurses are responsible for a wide range of medication-related tasks, from obtaining a comprehensive medication history to administering medications, monitoring for adverse effects, and educating patients on proper medication use [2]. Effective medication management is essential for promoting positive patient outcomes, reducing the risk of medication errors, and enhancing overall patient safety [3]. Nurses are often the last line of defense in the medication management process, and their vigilance and attention to detail can make the difference between a successful treatment and a potentially harmful outcome [4], so they must have sufficient knowledge and skill in the field of pharmacology and medication management to provide safe and quality care [5].

Medication errors are among the most common health-threatening mistakes that affect patient care, and they are considered a global problem that increases mortality rates, length of hospital stay, and related costs [6]. Factors contributing to medication errors include lack of pharmacological knowledge, using abbreviations instead of full drug names, similar drug names, high patient-to-nurse ratios, and failure to follow the “five rights” of medication administration (right patient, right drug, right dose, right route, and right time) [7,8]. Studies indicate that one of the main reasons for medication errors among nurses is their lack of experience and insufficient knowledge of medications [9]. Therefore, there is a need for increased attention to this aspect of nursing education.

Pharmacology is a critical subject in nursing education, as it equips nurses with the necessary knowledge and skills to ensure safe and effective medication administration [10,11]. Understanding pharmacology is essential for nurses to calculate correct dosages, recognize therapeutic success and adverse reactions, and make informed decisions regarding medication administration [12]. Teaching pharmacology is crucial for nursing students. Equipped with a solid understanding of pharmacology, students can contribute more effectively and safely to patient medication management [13,14].

The pharmacology course consists of theoretical and clinical internship sections for undergraduate nursing students in Iran. In this course, students are required to study and understand medications, the use and types of medications, and their side effects [15]. The effective teaching and learning of pharmacology is crucial for nurses to develop the necessary knowledge and skills to safely administer medications and provide optimal patient care [16,17]. Traditional didactic lecture-based approaches have been criticized for promoting passive learning and failing to adequately prepare nurses for real-world clinical application of pharmacological concepts [18, 19]. The traditional teaching approach focuses on lecture-based teaching, the teacher explains the theoretical knowledge, the students

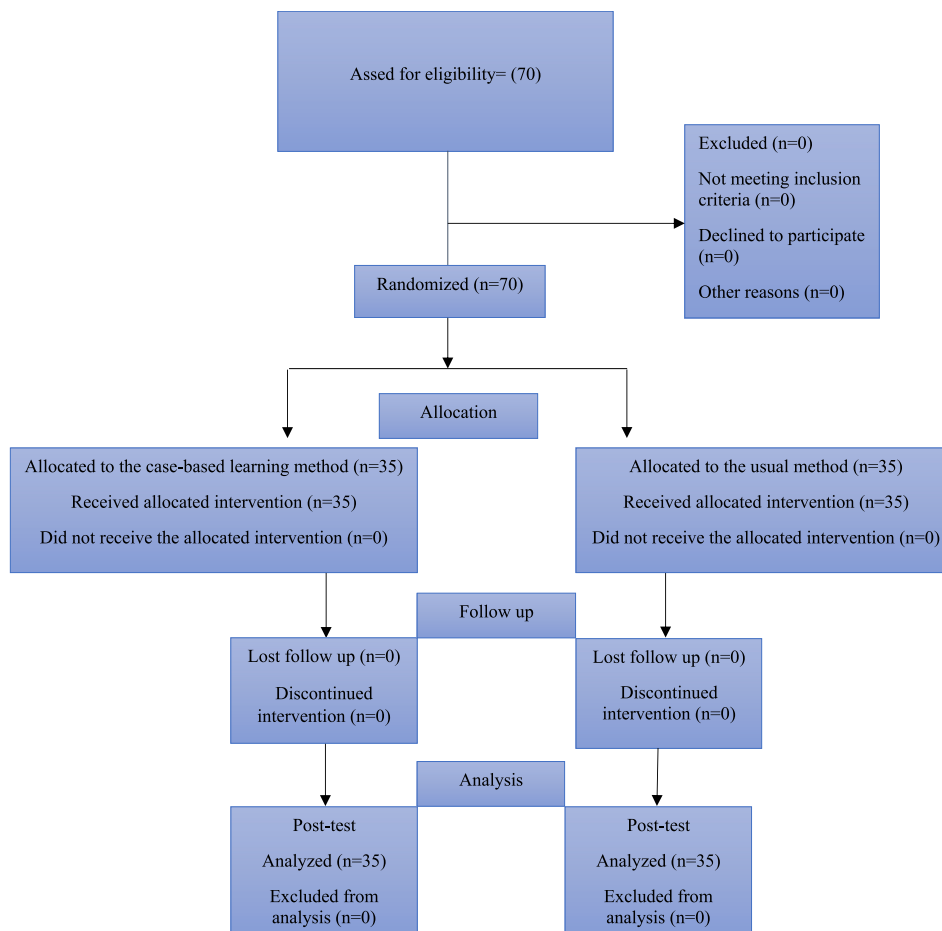


Fig. 1. Participants’ flow diagram.

listen and take notes and passively accept the knowledge, and this reduces the students' motivation to learn. This teaching method in the application of practical skills and the ability to use critical thinking skills is not effective [20].

One of the instructional methods that can enhance students' logical, analytical, clinical, and participatory skills and serve as an effective tool in filling existing gaps is case-based learning (CBL) [21]. CBL has emerged as an alternative teaching method that can better engage students and promote the integration of theory with practice [17]. CBL is an educational approach that focuses on a clinical problem, allowing students to identify their learning needs and search for foundational knowledge in real-life situations. This learning method leads to improved motivation, satisfaction, and student participation in learning [22].

The pharmacology course is presented in a large amount, in a short period, and usually in a traditional way for nursing students; weakness in traditional education is one of the causes of weakness in pharmaceutical education, which can increase the possibility of medication errors among nursing students [23]. However, the impact of CBL on pharmacology learning, specifically for nursing students, remains underexplored. Nursing education requires a strong emphasis on the clinical application of pharmacological principles to ensure safe medication management. Therefore, this study is designed to compare the impact of a case-based learning (CBL) approach with a lecture method on the satisfaction and learning of nursing students in pharmacology internships.

## 2. Materials and methods

### 2.1. Study design and setting

The present study is a randomized controlled trial of two groups that was conducted to investigate the effect of the case-based learning (CBL) approach on the level of satisfaction and learning of undergraduate nursing students during a pharmacology internship in 2023 at the Saveh University of Medical Sciences. This university is located in the central province of Iran. The nursing students at this university participate in a pharmacology internship course during the third semester (second year), following the theoretical component. The pharmacology internship is a mandatory course for nursing students in Iran and they are obligated to complete the pharmacology internship at a hospital under the supervision of an instructor. During this course, students become acquainted with various types of medications, their uses, and the methods of prescribing them. Under the supervision of an instructor, they practice the practical skill of administering medication to patients.

### 2.2. Sampling

The inclusion criteria for this study were third-semester nursing students who participated in the pharmacology internship. The exclusion criteria included non-participation in the pharmacology internship or absence from more than one session. All third-semester nursing students (70) who are eligible to participate in the medication internship were selected by census and divided into intervention (35) and control (35) groups through simple random sampling using a lottery system (Fig. 1). First, the last two digits of each student's ID number were written on a small piece of paper and then shuffled in a container. Subsequently, the papers were drawn out, their numbers noted, and this process continued until the desired sample size for either the intervention or the control group was reached. Once the required number of individuals for the intervention or control group was complete, the lottery process was concluded, and the selected individuals were assigned to one group while the remaining individuals were placed in the other group.

### 2.3. Measures

Data collection tools included a demographic questionnaire, satisfaction of educational approach questionnaire, and pharmacology exam score before and after the internship.

Demographic information questionnaire included: gender, age, employment, location, and GPA of the previous semester.

The students' learning levels were measured using a pharmacology exam administered before and after their internship. The content validity and level equivalence of the questions for both exams were evaluated by five faculty members.

The satisfaction of the educational approach questionnaire consisted of 11 questions with a five-option Likert scale (strongly agree to strongly disagree, rated from five to one). This questionnaire was adapted from the study by Vaezi et al. [24]. The content validity and reliability of this questionnaire were examined using Cronbach's alpha method ( $\alpha = 0.86$ ) in the mentioned study. The reliability of the questionnaire in the current study was calculated as 0.85 using Cronbach's alpha.

For CBL training, the Kaddoura method was used, including five stages of case presentation based on important content, creating a free and comfortable environment without threats for learners, participation of all learners in the discussion, and summarization of content by the instructor [25].

### 2.4. Participants recruitment and data collection

After introducing the purpose of the research and obtaining written consent, the students entered the research. Before starting the internship, a pharmacology pre-test was taken from the students of both groups to check their knowledge of the medicine course. The total number of educational sessions for both the intervention and control groups was nine sessions, which took place during the pharmacology internship at a university hospital. The students of the intervention group were trained in medication using the case-based learning (CBL) approach.

To carry out the CBL approach, in the first stage and before starting the internship by using the needs assessment of the students,

their educational needs in the subject of medication were identified, and the goals of each session were written and presented to the students before the internship started. A needs assessment was conducted based on pharmacology course objectives in the nursing curriculum in Iran.

In the second stage, based on the objectives of each internship day, the students read about the disease and the symptoms related to the disease, the tests and diagnostic tests related to the disease, and medications, their side effects, and important points in prescribing them.

In the third stage, at the beginning of each session, a patient case (in line with the purpose of the session) was introduced to the student, and the symptoms of the disease and its manifestations were examined and reviewed for the students at the patient's bedside by the instructor. Diagnostic tests, including laboratory tests and graphs related to those cases, were discussed, medications were prescribed for patients according to the patient's symptoms, and diagnostic tests were reviewed and explained with the participation of students.

In the fourth step, the instructor asked multiple questions regarding the relationship between prescribed medications, the pathophysiology of the disease, patient symptoms, and diagnostic test results from the students. All students were required to actively participate in the discussion. Finally, in the fifth stage, the presented content was summarized by the instructor.

For the intervention group, all educations were conducted at the patient's bedside, utilizing the patient's medical records, medication cards, and examination equipment.

For the control group of students, pharmacology education was conducted using the traditional method (lectures by the instructor and conferences with students). In this manner, during each day of the internship, one of the medication classes was presented by the students through lectures. Subsequently, additional explanations were provided by the instructor. The lectures were conducted in the hospital conference room, utilizing PowerPoint presentations.

An instructor with a master's degree in nursing was responsible for training the groups. The instructor for the students of the intervention and control groups was the same. This approach was taken to mitigate potential errors in intervention execution that may arise from differences in teaching styles and subject mastery among different instructors. Additionally, the objectives and educational content for both groups were identical.

One week after completing the internship, the students of the intervention and control groups were asked to complete the pharmacology post-test and a questionnaire about satisfaction with the educational approach. Then the scores of pharmacology pre-test and post-test and satisfaction questionnaire of both groups were compared.

## 2.5. Statistical analysis

Statistical analysis was performed using SPSS version 26 software. The Shapiro-Wilk test was employed to assess the normality of the data, revealing that all quantitative variables, including age, previous semester GPA, pre-and post-test scores, and overall satisfaction score with the instructional method, did not follow a normal distribution ( $P < 0.05$ ). Descriptive statistics such as mean, standard deviation, absolute, and relative frequency were utilized to report demographic variables of the participants. The Chi-square, Fisher's exact, and Mann-Whitney tests were employed to compare demographic variables between the two groups. To determine the impact of the CBL approach on participant satisfaction and learning, Wilcoxon and Mann-Whitney tests were utilized.

## 3. Results

Analysis of the demographic data revealed that 61.4 percent of the samples were male, while the remaining samples were female.

**Table 1**  
Comparison of demographic information of participants in two intervention and control groups (Demographic questionnaire).

Variables	Grouping	Intervention	Control	Total number	Significance Level
		Number (Percentage)	Number (Percentage)		
Gender	Woman	14 (40)	13 (37.1)	27 (38.6)	0.50 <sup>a</sup>
	Man	21 (60)	22 (62.9)	43 (61.4)	
Age employment	Mean $\pm$ Standard Deviation	20.38 $\pm$ 3.36	20.87 $\pm$ 2.52		0.76 <sup>***</sup>
	Student work	9 (25.7)	3 (8.6)	12 (17.1)	0.12 <sup>b</sup>
	Employment outside of the university	2 (5.7)	1 (2.9)	3 (4.3)	
Location	unemployed	24 (68.6)	31 (88.6)	55 (87.6)	0.67 <sup>b</sup>
	Student Dormitory	20 (57.1)	21 (60)	41 (58.6)	
	Student House	2 (5.7)	1 (2.9)	3 (4.3)	
	Family	12 (34.3)	12 (34.3)	24 (34.3)	
The average GPA of the previous semester	Unanswered	1 (2.9)	1 (2.9)	2 (5.7)	0.58 <sup>***</sup>
	Mean $\pm$ Standard Deviation	16.39 $\pm$ 2.47	16.56 $\pm$ 1.89		

\*\* Mann-Whitney test.

<sup>a</sup> Fisher's test

<sup>b</sup> Chi-square test.

The majority of the samples were not employed during their academic tenure and resided in student dormitories. The mean age of the samples in the intervention group was  $20.38 \pm 3.36$ , while in the control group, it was  $20.87 \pm 2.52$ . The average GPA of the past semester in the intervention group was  $16.39 \pm 2.47$ , compared to  $16.56 \pm 1.89$  in the control group. The demographic information of the research units according to intervention and control groups is reported in Table 1. Based on the results, there is no significant difference between the intervention and control groups in terms of demographic variables.

According to the results of this research, the pre-test scores of pharmacology in the intervention and control groups did not have a statistically significant difference ( $P = 0.88$ ). After the intervention, the post-test scores in the intervention group were higher than in the control group, but this difference was not statistically significant at the 0.05 level (Table 2).

A comparison of pre-test and post-test scores in control and intervention groups showed that the post-test scores in both groups increased significantly ( $P < 0.001$ ).

The CBL approach compared to the usual method (lecture) has not significantly increased the learning rate of medication among nursing students (Table 2). However, the analysis of the satisfaction questionnaire scores revealed that the intervention group exhibited significantly ( $P = 0.008$ ) higher satisfaction with the educational approach compared to the control group (Table 3).

#### 4. Discussion

The results of the present study showed that the students of both groups (trained with CBL and lecture methods) demonstrated a significant increase in post-test scores, indicating an overall improvement in medication knowledge regardless of the learning approach. Surprisingly, the CBL method did not yield a statistically significant difference in learning outcomes compared to the traditional lecture-based approach. This finding challenges the assumption that CBL inherently leads to superior learning outcomes in pharmacology education.

Despite similar learning outcomes, the intervention group expressed significantly higher satisfaction with the CBL method compared to the control group. This suggests that while both approaches may be equally effective in facilitating learning, students perceived CBL as more engaging or beneficial, thus enhancing their satisfaction with the educational experience. In line with the findings of the current study, the results of the study by Kaur et al. demonstrated that despite the lack of a significant difference between the mean scores obtained by students in the CBL and traditional methods ( $P = 0.98$ ), the majority of students (84 %) felt that the CBL method was a better approach for pharmacology education compared to the traditional method (22).

Contrary to the current research findings, which did not show a significant difference in learning outcomes between the groups trained by CBL and lecture, some studies reported a significant difference in the learning of students trained with these two methods [16,18,26]. For example, one study involving 68 nursing students found that the CBL group had significantly higher test scores in knowledge-based and clinical application questions compared to the lecture group [18]. Another study with 90 medical students found that while the CBL group had better post-test scores than the lecture group, the lecture method showed significantly better immediate learning outcomes. However, there was no difference in long-term retention between the two methods [16].

One reason for the absence of a significant difference in the pharmacology post-test scores between the two groups in our study could be due to differences in students' learning approaches in these two teaching methods. Several studies have found that CBL leads to better critical thinking, self-directed learning, and clinical application compared to traditional lectures, leading to greater student satisfaction and confidence [18,22,27–29]. As an example, in Kaur's study, the results indicated that students taught using the CBL method achieved better grades for questions requiring critical thinking, whereas students taught through the lecture-based method obtained higher scores for knowledge-based questions compared to the CBL approach [22]. Furthermore, in the study of Chiranjeevi et al., which was conducted to examine the effectiveness of CBL compared to conventional teaching methods in pharmacology education, the findings indicated that the CBL group significantly achieved higher scores compared to the lecture group in application-based questions. However, in knowledge-based questions, despite the higher scores, there was no statistically significant difference in scores between the CBL and lecture groups [28].

Another justification for the lack of significant difference in learning between the two groups in the present study could be that we assume students may have been engaged in discussions and exchanged their knowledge about pharmacology and medication management during non-academic hours, such as in dormitories or extracurricular classes. This additional discourse may have led to increased repetition of medication-related topics among students and could have resulted in the observed post-test scores being higher in the CBL group. However, statistically, this difference may not be significant compared to lecture-based learning.

Other factors, such as the duration of the intervention, the pharmacology exam questions used to evaluate student learning, and the type of content taught could account for the absence of a significant difference in post-test scores between the two study groups. It is

**Table 2**

Comparison of mean and standard deviation of pre-test and post-test scores of pharmacy internship in two stages before and after the intervention in the intervention and control groups (Exam score).

	Group	Intervention	Control	Significance Level
Before	Mean $\pm$ Standard Deviation	10.6 $\pm$ 3.49	10.54 $\pm$ 2.47	<sup>b</sup> 0.88
After	Mean $\pm$ Standard Deviation	18.07 $\pm$ 0.91	17.7 $\pm$ 1.15	<sup>b</sup> 0.19
	Significance Level	<sup>a</sup> 0.000	<sup>a</sup> 0.000	

<sup>a</sup> Wilcoxon test.

<sup>b</sup> Mann-Whitney test.

**Table 3**

Comparison of the level of satisfaction with the learning method in the intervention and control groups (Satisfaction of educational approach questionnaire).

Group	Intervention	Control
Mean ± Standard Deviation	44.36 ± 6.61	41.73 ± 5.80
Significance level	<sup>a</sup> 0.008	

<sup>a</sup> Mann-Whitney test.

suggested that similar studies comparing the effect of CBL to conventional methods, with longer intervention durations and focusing on teaching various nursing subjects, be conducted.

In the present study, participants trained through the CBL method were more satisfied with this instructional approach. In alignment with this finding, in most studies, students were more satisfied with the CBL method [18,22,27–30]. The results of Garg et al.'s study showed that 95 % of students agreed that CBL helps to better understand concepts and 96 % of the students found this method interesting and also stated that this method helps them to improve the clinical application of pharmacology [30]. Similarly, the results of the study by Gajanan et al., showed that 80.4 % of the participants reported the CBL method as beneficial and expressed satisfaction with this instructional strategy. They believed that this method helped enhance their understanding of the subject [26]. In the study by Chiranjeevi et al., approximately 90 % of the students had positive opinions about CBL and emphasized the implementation of this teaching method in other courses [28]. CBL is an inquiry-based model that encourages students to argue, discuss, and collaborate. It is a comprehensive form of learning that leads to improved communication skills, collaborative learning, and increased interest in clinical subjects [28]. CBL offers several advantages over traditional didactic methods. Firstly, it fosters active student engagement, contrasting with the passive nature of traditional teaching. Secondly, CBL facilitates the application and integration of knowledge, collaboration, and problem-solving skills, unlike the solely content-focused approach of traditional teaching. Thirdly, CBL provides opportunities for feedback and discussion with experts, enhancing comprehension compared to lectures with minimal feedback. Additionally, CBL promotes deep understanding and high-level learning, encouraging learners to conceptualize knowledge and apply it effectively to new situations, rather than relying on rote memorization [21,29].

Despite the lack of difference in learning outcomes, the higher satisfaction reported by the CBL group is an important finding. Increased student satisfaction can lead to greater engagement, motivation, and ultimately, better long-term learning outcomes. The CBL approach may also better prepare students for real-world clinical practice by providing them with opportunities to apply their knowledge to realistic scenarios. Further research with a larger sample size and from multiple centers with a longer intervention period is needed to draw conclusions about the effect of the CBL method on student satisfaction and learning in nursing education.

#### 4.1. Strengths and limitations

This study provides evidence for the implementation of the CBL method for pharmacology learning in nursing students. Random allocation of samples, utilization of standardized questionnaires, and psychometric validation of educational content have enhanced the scientific credibility of this research. However, this study also had its limitations; due to the limited availability of samples, participants were initially selected through a census method and then randomly assigned to two groups. Additionally, all samples were from a single university center, which may limit the generalizability of the findings. The short duration of the intervention and the lack of a follow-up period were among the other limitations of this study. It is suggested that in future research, the intervention duration be extended and the learning of students during the follow-up period also be examined to compare the retention of learned materials over time between the CBL and the traditional methods.

In the CBL approach, the diversity of patient cases and their absence in various educational sessions can lead to variability in the content presented to students. These differences may result in different outcomes and ultimately pose challenges. Moreover, this learning method may not have global applicability due to the extensive diversity of medication classifications and the lack of suitable patient cases for all medication groups. However, it can serve as a valuable complementary approach alongside traditional lecture-based methods for pharmacology education.

## 5. Conclusion

Based on the findings of this study, the CBL approach in a nursing pharmacology internship led to higher student satisfaction compared to a traditional lecture-based approach but did not result in significantly better learning outcomes. These findings raise important questions about the efficacy of different teaching methods in pharmacology education. While traditional lectures remain a cornerstone of many educational programs, the preferences and satisfaction of students should also be considered when designing curriculum and instructional strategies. Further research could explore the long-term retention of knowledge and application of skills acquired through different teaching methods to provide a more comprehensive understanding of their impact on nursing education.

## Ethics approval

This study was derived from the research proposal of Saveh University of Medical Sciences. The study protocol was approved by the Ethics Committee of Saveh University of Medical Sciences (Code:IR.SAVEHUMS.REC.1401.028) and complied with the requirements

of the Helsinki Declaration.

Written informed consent was obtained from all participants to voluntarily participate in the research. Participants were informed that their participation in the study was optional and that they had the right to withdraw if they did not wish to continue their participation. All participant information was analyzed and reported confidentially. The rights of authors of used texts in the research were respected, with proper citation of the sources.

#### Data availability statement

The datasets used or analyzed during the present study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical restrictions.

#### CRedit authorship contribution statement

**Farzaneh Arab:** Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Maryam Saeedi:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e35149>.

#### References

- [1] A. Hanson, L.M. Haddad, Nursing Rights of Medication Administration. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: lisa Haddad declares no relevant financial relationships with ineligible companies, in: StatPearls Publishing Copyright © 2024, StatPearls Publishing LLC., 2024.
- [2] A. Mardani, P. Griffiths, M. Vaismoradi, The role of the nurse in the management of medicines during transitional care: a systematic review, *J. Multidiscip. Healthc.* 13 (2020) 1347–1361.
- [3] A.A. Mutair, S. Alhumaid, A. Shamsan, A.R.Z. Zaidi, M.A. Mohaini, A. Al Mutairi, et al., The effective strategies to avoid medication errors and improving reporting systems, *Medicine (Baltim.)* 8 (9) (2021).
- [4] M. Guillaudin, O. Galvez, V. Jandard, G. Camus, M. Paillet, X. Bohand, [The nurse as the last line of defence against quality defects in medicines], *Revue de l'infirmiere (181)* (2012) 42–44.
- [5] F. Zareie, S. Orojlu, D. Rasuli, O. Naseri, S. Shams, Lack of knowledge of pharmacology in nursing students rate, causes and solutions, *Nurs. Midwifery J.* 11 (6) (2013), 0.
- [6] A. Shahrokhi, F. Ebrahimpour, A. Ghodousi, Factors effective on medication errors: a nursing view, *J. Res. Pharm. Pract.* 2 (1) (2013) 18–23.
- [7] A. Alandajani, B. Khalid, Y.G. Ng, M. Banakhar, Knowledge and attitudes regarding medication errors among nurses: a cross-sectional study in major Jeddah hospitals, *Nurs. Rep.* 12 (4) (2022) 1023–1039.
- [8] K. Zarea, A. Mohammadi, S. Beiranvand, F. Hassani, S. Baraz, Iranian nurses' medication errors: a survey of the types, the causes, and the related factors, *Int. J. Africa Nurs. Sci.* 8 (2018) 112–116.
- [9] E. Jaafari-pooyan, Z. Madady, Nursing medication errors: causes and solutions (A review study), *Hospital* 14 (3) (2015) 101–110.
- [10] R. Krone, The impact of pharmacology in nursing education in a concept-based curriculum, SACAD: John Heinrichs Scholarly and Creative Activity Days. 2023 2023 (2023) 88.
- [11] H.N. Rubaiy, Strategies to inspire students' engagement in pharmacology courses, *Pharmacy* 9 (2) (2021) 70.
- [12] E. De Baetselier, T. Dilles, H. Feyen, F. Haegdorens, L. Mortelmans, B. Van Rompaey, Nurses' responsibilities and tasks in pharmaceutical care: a scoping review, *Nurs. Open* 9 (6) (2022) 2562–2571.
- [13] S. Stolic, L. Ng, J. Southern, G. Sheridan, Medication errors by nursing students on clinical practice: an integrative review, *Nurse Educ. Today* 112 (2022) 105325.
- [14] Z. Mehdi, R. Nasser, H. Theobald, K. Schoemann, Health workers' educational training and staffing concerning medication errors, fall injuries, and complaints among older adults, *Global J. Health Sci.* 11 (3) (2019) 111.
- [15] M. Al-Okaily, H. Alqudah, A. Matar, A. Lutfi, A. Taamneh, Dataset on the acceptance of e-learning system among universities students' under the COVID-19 pandemic conditions, *Data Brief* 32 (2020) 106176.
- [16] T.S. Padmanabha, Y.D. Shilpashree, N. Ajay, H.G. Kshamaa, H.L. Tejaswi, S.K. Raghavendra, Is there a case for case-based learning in pharmacology? *Cureus* 15 (6) (2023) e39835.
- [17] M. Sood, K. Kaur, R. Arora, Introduction of case-based learning to teach Pharmacology to second year MBBS students, *Int. J. Basic Clin. Pharmacol.* 10 (2021) 176–181.
- [18] M.B. Vora, C.J. Shah, Case-based learning in pharmacology: moving from teaching to learning, *Int. J. Appl. Basic Med. Res.* 5 (Suppl 1) (2015) S21–S23.

- [19] Altınbaş Y, İster ED, Learning experiences of nursing students with case-based learning technique: a qualitative stu. *Kahramanmaraş Sütçü İmam Üniversitesi Tıp Fakültesi Dergisi*.18(2):45-52.
- [20] B.L. Dickinson, W. Lackey, M. Sheakley, L. Miller, S. Jevet, B. Shattuck, Involving a real patient in the design and implementation of case-based learning to engage learners, *Adv. Physiol. Educ.* 42 (1) (2018) 118–122.
- [21] A. Nishal, J. Patel, R. Balvalli, P.P. Yadav, P. Jayani, R. Singh, et al., A comparative study of case-based learning vs. Traditional teaching method in pathology in Indian medical graduates, *J. Med. Educ.* 21 (1) (2022).
- [22] G. Kaur, J. Rehncy, K.S. Kahal, J. Singh, V. Sharma, P.S. Matreja, et al., Case-based learning as an effective tool in teaching pharmacology to undergraduate medical students in a large group setting, *J. Med. Educ. Curric. Dev.* 7 (2020) 2382120520920640.
- [23] V. Rahimi, M. Heidari, S. Naeimi, K. Moradbeigi, The Effect of Targeted and Game-Based Pharmacology Education on Nursing Students' Pharmacology Scores, 2021.
- [24] A. Vaezi, F. Azizian, J. Kopayehzadeh, Survey compare team based learning and lecture teaching method, on learning-teaching process nursing student's, in surgical and internal diseases course, *J. Med. Educ. Dev.* 10 (3) (2015) 246–254.
- [25] M.A. Kaddoura, Critical thinking skills of nursing students in lecture-based teaching and case-based learning, *Int. J. Scholarsh. Teach. Learn.* 5 (2) (2011) n2.
- [26] D. Gajanan, C. Gaurav, K. Vishal, Student perception and effectiveness of case based learning in pharmacology, *Pravara Med. Rev.* 12 (4) (2020).
- [27] M. Shohani, M. Bastami, L.A. Gheshlaghi, A. Nasrollahi, Nursing student's satisfaction with two methods of CBL and lecture-based learning, *BMC Med. Educ.* 23 (1) (2023) 48.
- [28] U.K. Chiranjeevi, V. Gedela, G.H.J. Rao, A comparative study of case-based learning with conventional teaching in undergraduate training of pharmacology, *Natl. J. Physiol. Pharm. Pharmacol.* 12 (5) (2022) 712–716.
- [29] M. Bi, Z. Zhao, J. Yang, Y. Wang, Comparison of case-based learning and traditional method in teaching postgraduate students of medical oncology, *Med. Teach.* 41 (10) (2019) 1124–1128.
- [30] P. Garg, S. Bhanwra, Case based learning in teaching pharmacology to undergraduate medical students, *Cureus* 14 (9) (2022) e29187.