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Impact of the "Learning by Teaching" Approach on Nursing Students' Knowledge and Practical Skill Acquisition: A Quasi-Experimental Investigation

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Abstract

The learning-by-teaching strategy represents an active learning model centered on the learner. In nursing education, where students must acquire diverse competencies and practical abilities, the use of dynamic, student-driven instructional approaches is crucial. This study aimed to evaluate how the learning-by-teaching method influences nursing students' knowledge acquisition and skill performance during clinical skills training. A quasi-experimental study with no control group was conducted between November 2022 and February 2023, involving 206 senior nursing students. Participants underwent 14 weeks of instruction covering "intravenous catheter insertion and medication administration" and "intramuscular and subcutaneous injection techniques," applying the learning-by-teaching approach through group-based activities. Throughout the program, students developed and delivered educational materials such as PowerPoint slides, posters, banners, instructional videos, and practical demonstrations. Knowledge assessments were administered before and three weeks after the training, and performance was measured using the Objective Structured Clinical Examination (OSCE). Participants had a mean age of 21.8 ± 1.31 years (range = 20–28), with 68.4% (n = 141) being female and an average GPA of 3.05 ± 0.27. All comparisons revealed statistically significant improvements between pre-test and post-test scores for both theoretical knowledge and practical skills across all groups ($p < 0.05$). The findings demonstrate that the learning-by-teaching model significantly enhances nursing students' theoretical understanding and clinical skill proficiency across all evaluated topics, confirming its effectiveness as an active instructional method in nursing skills education.

Keywords: Learning-by-teaching method, Skills training, Nursing education

Introduction

In the modern healthcare landscape, where rapid technological advancement continuously reshapes clinical practice, the effective preparation of healthcare professionals has become a global priority. Students equipped with adaptive skills and forward-thinking perspectives can serve as catalysts for progress within this evolving environment [1]. Consequently, contemporary educational paradigms emphasize learner-centered approaches that promote active engagement and self-directed learning [2]. Among these, the learning-by-teaching model stands out as a dynamic instructional method that assigns students the role of educators, fostering both autonomy and accountability in the learning process. Originally conceptualized by Jean-Pol Martin for foreign language instruction, this model has been widely adopted across German educational systems [1,2]. Within this framework, learners assume partial or complete responsibility for conducting lessons or facilitating specific activities for their peers [2–5].

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Unlike traditional instruction, this approach requires students not only to convey content but also to design and implement their own teaching strategies, encouraging deeper conceptual understanding and creativity [4–6]. Instructors act primarily as facilitators and mentors, guiding students through the process of knowledge discovery and reflection [5]. The learning-by-teaching method nurtures a broad range of 21st-century competencies—such as creativity, autonomy, confidence, self-efficacy, collaboration, empathy, communication, critical and analytical thinking, information literacy, decision-making, presentation ability, and motivation [4,5,7,8].

In today's nursing profession, practitioners are expected to integrate cognitive, affective, and psychomotor competencies, including problem-solving, critical thinking, teamwork, adaptability, and effective intercultural communication [9,10]. To cultivate these capabilities, nursing education must incorporate flexible, innovative, and student-driven teaching methodologies. The learning-by-teaching model provides a powerful framework to achieve this goal.

Previous research has examined this pedagogical approach across various academic fields. Hanbay (2009) observed positive outcomes using a "learning-by-teaching method based on the quantum learning approach" for German language instruction [2]. Similarly, Serindağ (2007) found no significant difference in outcomes between students who taught lessons themselves and those taught by instructors, suggesting that peer-led teaching fosters autonomous and lifelong learning [3]. Aslan reported that this model improved inquiry skills among preservice science teachers [11], while another study by Aslan demonstrated enhanced attitudes toward chemistry [7].

Despite its benefits, limited evidence exists regarding the application of learning-by-teaching in nursing education—particularly within clinical skills training. Exploring this pedagogical strategy in nursing contexts may yield valuable insights for developing effective, learner-centered teaching practices that strengthen both knowledge and clinical competence. Accordingly, the present study investigates how implementing the learning-by-teaching approach affects nursing students' theoretical understanding and skill proficiency during practical training. The findings aim to support evidence-based integration of this model into nursing curricula and promote essential 21st-century professional competencies.

Methods

Study design

This research adopted a quasi-experimental, single-group pretest–posttest design to evaluate the impact of the learning-by-teaching method on nursing students' knowledge and skill acquisition during clinical training.

Research hypotheses

H1: The learning-by-teaching approach in nursing skills training positively influences students' knowledge levels.
H2: The learning-by-teaching approach in nursing skills training positively influences students' practical skill levels.

Participants and setting

The study was conducted between November 2022 and February 2023 at a university in western Türkiye, involving fourth-year students enrolled in the nursing faculty. The target population comprised 264 students, with 206 ultimately participating after excluding those who missed sessions or failed to complete either the pre- or post-assessments. Inclusion criteria required being a fourth-year nursing student enrolled in the Teaching in Nursing course, attending at least 80% of sessions, and completing both evaluations. A post-hoc power analysis (effect size = 0.25, $\alpha = 0.05$, $F = 2.258$) using G-Power 3.1.9.4 indicated a statistical power of 0.78, with a minimum of 170 participants required to achieve 0.8 power.

The Teaching in Nursing course consisted of four hours of theory and four hours of practice weekly. The theoretical portion covered topics such as instructional planning, educational objectives, learning theories, nursing-specific teaching methods, teaching aids, clinical instruction, adult learning principles, and the teaching process. The practical component required students to select a topic, develop a lesson plan, apply active learning strategies and methods, design educational materials, present them effectively, and engage in collaborative evaluation through group work.

Instruments

Data were gathered through three main tools: a sociodemographic information form, a knowledge assessment questionnaire, and a skills evaluation checklist designed for the Objective Structured Clinical Examination (OSCE).

Descriptive information form

This form, developed by the researchers, collected participants' basic demographic and educational information.

Knowledge questionnaires

To measure students' theoretical understanding, the researchers created questionnaires based on an extensive review of previous studies [12–15]. Each questionnaire contained ten open-ended questions addressing two main skill areas: intravenous drug administration via catheter insertion, and intramuscular and subcutaneous injection procedures. The content validity of the questionnaires was established through expert evaluation by five independent nursing education specialists—two full professors and three PhD-qualified academics—who were not affiliated with the research team. Their feedback ensured the clarity and relevance of the questions. Additionally, a pilot test involving ten third-year nursing students was conducted to confirm the comprehensibility of the items. Following necessary revisions, the final version of each questionnaire was scored on a 100-point scale (Supplementary 1).

Skills checklists

The skills checklists served as structured evaluation tools within the OSCE to assess students' performance step by step for each clinical skill. According to the literature, OSCEs are reliable measures of knowledge, attitude, and technical competence [16]. In this study, three individual checklists were designed for the three clinical skills included in the training, following guidelines from prior research [15,17]. These checklists were reviewed by five experts in nursing education (two professors and three PhD holders) to confirm their validity. After a pilot trial with ten third-year students, revisions were made to improve clarity and applicability, and each checklist was finalized. Each skill assessment was scored out of 100 points (Supplementary 2).

Procedure

The study was implemented following the learning-by-teaching approach, progressing through several structured phases **(Figure 1)**.

Stage 1: Orientation and preparation

Prior to the intervention, researchers conducted an orientation session in which students were introduced to the learning-by-teaching methodology through lectures, videos, and visual materials. The aims, structure, and expectations of the method were thoroughly explained, and students' questions were addressed to ensure understanding.

Stage 2: Group formation and baseline assessment

Participants were randomly divided into three main groups, each assigned one of the three predetermined training topics through a lottery method. Before instruction began, all students completed the demographic form and the knowledge questionnaire relevant to their assigned topic. They were also evaluated using the OSCE to measure baseline skill proficiency. Separate OSCE stations were set up for each specific clinical skill, where students individually performed the tasks within a fixed time frame. Each performance was scored using the corresponding checklist. Following the completion of these initial assessments, a structured schedule for the learning-by-teaching activities was developed collaboratively with students.

Stage 3: Learning by teaching implementation (Figure 2)

Each main group was further divided into smaller subgroups of approximately 14–15 students. These subgroups conducted comprehensive literature reviews on their assigned topics, discussed their findings collectively, and collaboratively determined the content, depth, and delivery methods of their teaching sessions. Students designed educational plans that specified learning objectives, instructional strategies, teaching tools, and evaluation techniques, drawing on theoretical knowledge acquired in their coursework.

They created written materials summarizing theoretical content and developed teaching aids such as PowerPoint slides, posters, and other visual supports. For practical skills training, the students prepared relevant materials, models, and instructional videos, and selected suitable teaching techniques (e.g., demonstration, peer instruction). Throughout the preparation phase, researchers provided continuous mentorship, advising students on sourcing educational materials and refining their teaching strategies.

Once preparations were completed, the student groups conducted their teaching sessions using the instructional plans, tools, and techniques they had independently designed.

Stage 4: Post-Training assessment

Three weeks after completing the teaching sessions, post-training evaluations were conducted. The same knowledge questionnaires used in the pre-assessment were re-administered to measure knowledge retention, and the OSCE was repeated to assess skill improvement. These post-training evaluations enabled a direct comparison of students' progress in both theoretical understanding and practical performance after engaging in the learning-by-teaching process.

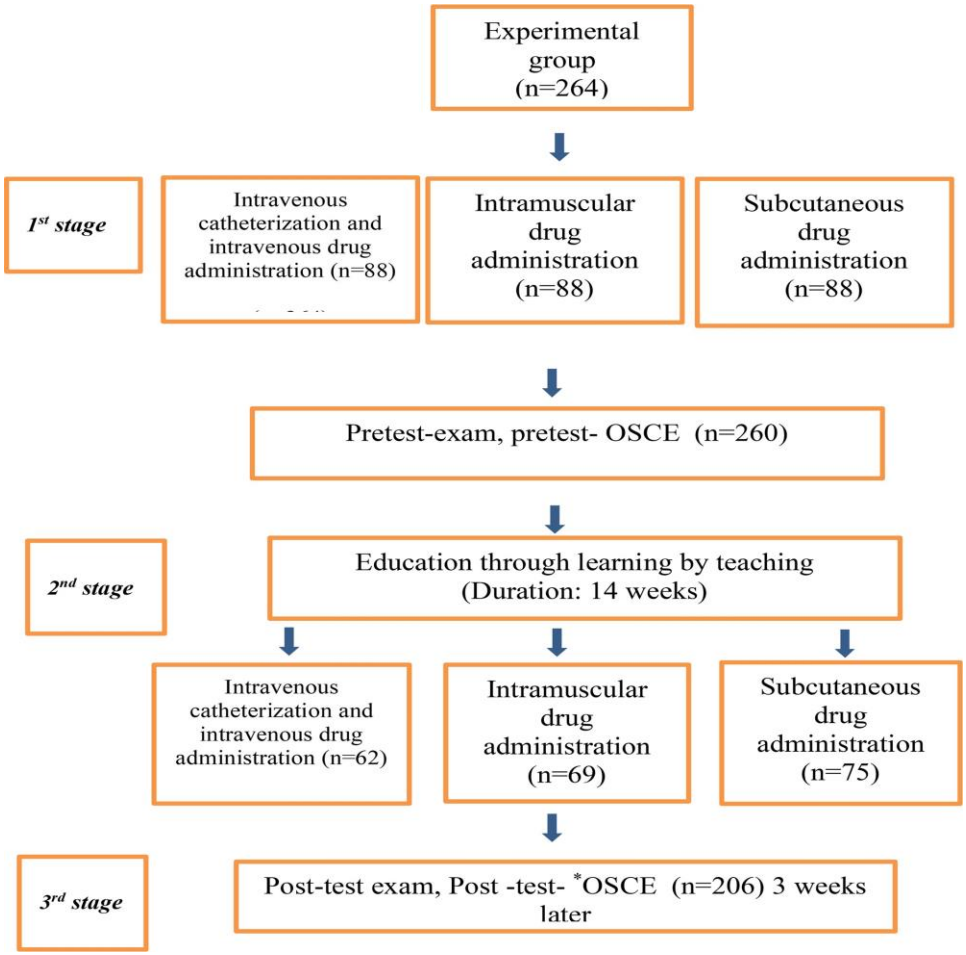

Figure 1. Research procedure. *OSCE, objective structured clinical examination

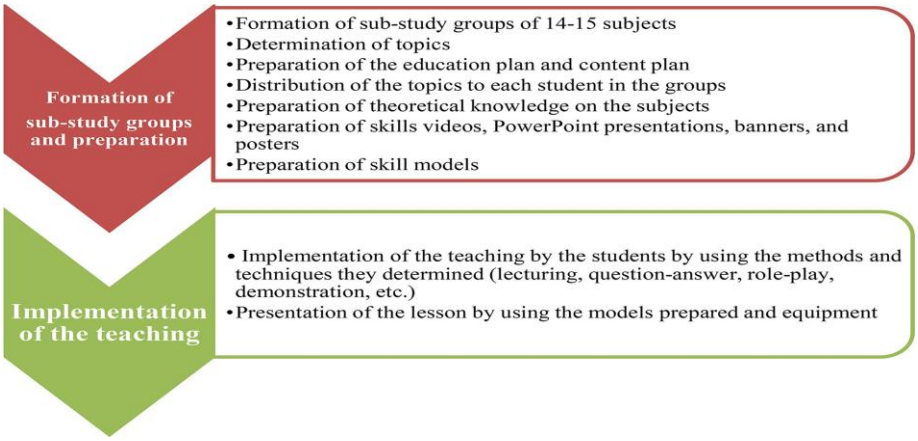

Figure 2. Stages of the learning-by-teaching method

Ethical considerations

This research received ethical approval from the Adnan Menderes University Nursing Faculty Non-Interventional Ethics Committee (Protocol No: E-76261397-050.99-257169, dated October 17, 2022). All study procedures adhered to the ethical standards outlined in the Declaration of Helsinki.

Prior to participation, students were thoroughly informed about the study's objectives, procedures, and their rights. Because the study was non-invasive and posed no physical or psychological risk, verbal informed consent was obtained, as authorized by the Ethics Committee. Throughout the study, participant anonymity and confidentiality were rigorously maintained.

Data analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (SPSS Inc., IL, USA). Descriptive statistics—including frequency, percentage, mean, and standard deviation—were used to summarize the data. To compare pretest and posttest results within groups, the dependent samples t-test was applied, while the paired samples t-test was used to compare mean values between groups. Additionally, effect sizes were calculated using Cohen's d to assess the practical significance of observed differences. A p-value of less than 0.05 was considered statistically significant for all analyses.

Results

Participants had a mean age of 21.8 ± 1.31 years (range: 20–28), with 68.4% (n = 141) identifying as female. The majority (88.8 percent, n = 183) were graduates of general high schools, 56.3 percent (n = 116) reported having balanced income and expenses, and 6.3 percent (n = 13) were employed part-time. The students' average Grade Point Average (GPA) was 3.05 ± 0.27, ranging from 2.01 to 3.60 **(Table 1)**.

Table 1. Students' descriptive characteristics (*n* = 206)

Characteristics	Count	%
Age Mean = 21.8 ± 1.31		
Gender		
Female	141	68.4
Male	65	31.6
High school		
General high school	183	88.8
Health vocational high school	12	5.8
Associate degree	6	2.9
Undergraduate degree	5	2.4
Status of employment		
Yes	13	6.3
No	193	93.7
Level of income		
Income < expenses	68	33.0
Income = expenses	116	56.3
Income > expenses	22	10.7
GPA = 3.05 ± 0.27		

A highly significant rise was observed in the mean scores between the pre-test and post-test across all assessments ($p < 0.001$). Beyond statistical significance, effect size analysis revealed substantial improvement, with Cohen's d values ranging from 2.16 to 2.95, demonstrating that the intervention produced a strong and practically meaningful enhancement in students' knowledge and skill performance **(Table 2)**.

Table 2. Comparison of students' mean pre-training and post- training total scores (*n* = 206)

Exams	Mean ± SD	95% confidence interval		t/p	Cohen's d
		Lower	Upper		
Pre-test exam	13.70 ± 10.56	-56.57	-51.53	t=-42.309	2.95
Post-test exam	67.75 ± 19.80			*p* < 0.001	
Pre-training OSCE	36.18 ± 18.52	-46.45	-40.90	t=-31.014	2.16
Post- training OSCE	79.86 ± 13.16			*p* < 0.001	

Data are expressed as mean ± standard deviation. Paired t-tests were applied to assess differences between pre-test and post-test scores, while effect sizes (Cohen's d) were computed to determine the strength of these differences. Abbreviations: SD = Standard Deviation; t = t-value; p = significance level; d = Cohen's d. A Cohen's d value exceeding 0.8 represents a large effect size.

Likewise, a significant difference was observed between the overall mean pre-test and post-test scores across all groups ($p < 0.001$). Effect size analysis indicated that although every group gained from the learning-by-teaching method, the level of progress was not uniform. For instance, students in the intravenous administration group exhibited the smallest score increase (from 6.82 to 48.29; Cohen's d = 1.35), while those in the subcutaneous injection group achieved the greatest improvement (from 17.65 to 79.65; Cohen's d = 2.35). These results suggest that, although the learning-by-teaching strategy enhanced performance in all cases, its effectiveness varied according to the type of clinical skill being taught **(Table 3)**.

Table 3. Comparison of students' mean pre-test and post-test total scores according to study groups ($n = 206$)

Groups	Pre-test exam score	Post-test exam score	t/*p* Cohen's d	Pre-test OSCE score	Post-test OSCE score	t/*p* Cohen's d
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Intravenous catheterization application and drug administration through the catheter ($n = 62$)	6.82 ± 5.02	48.29 ± 16.45	t=-19.40 $p < 0.001$ Cohen's d = 1.35	39.54 ± 18.01	81.19 ± 10.64	t=-16.14 $p < 0.001$ Cohen's d = 1.12
Intramuscular drug administration ($n = 69$)	15.60 ± 11.92	72.32 ± 16.13	t=-29.04 $p < 0.001$ Cohen's d = 2.02	38.00 ± 18.76	75.55 ± 14.79	t=-16.81 $p < 0.001$ Cohen's d = 1.17
Subcutaneous drug administration ($n = 75$)	17.65 ± 9.95	79.65 ± 11.98	t=-33.77 $p < 0.001$ Cohen's d = 2.35	31.74 ± 18.09	82.74 ± 12.58	t=-46.49 $p < 0.001$ Cohen's d = 3.24

The data are expressed as mean ± standard deviation. Comparisons between pre-test and post-test scores were analyzed using paired t-tests. Effect sizes, represented by Cohen's d, were computed to assess the strength of the differences. SD = Standard Deviation; t = t-value; p = significance level; d = Cohen's d. A Cohen's d value exceeding 0.8 denotes a large effect size.

Discussion

This study aimed to evaluate how the learning-by-teaching approach influences nursing students' theoretical understanding and practical skill performance. The findings revealed that employing the learning-by-teaching strategy significantly enhanced both knowledge and psychomotor competence among the participants in nursing skills training.

Existing literature supports these outcomes, demonstrating that learning by teaching enables students to grasp material more effectively than conventional lecture-based or exam-focused methods. This advantage is especially evident in long-term knowledge retention, skill mastery, and improved self-confidence [18-22]. Additionally, learners who designed and delivered instructional materials during the teaching phase showed more profound comprehension, higher engagement, and greater skill improvement than those who prepared individually for exams [23-27]. The current study's findings align with these reports, affirming that this approach strengthens both theoretical learning and hands-on proficiency in nursing education.

Although no prior experimental research in nursing has exclusively investigated the learning-by-teaching technique, comparable benefits have been documented with other active learning frameworks such as simulation, flipped classrooms, and augmented reality. While these models are grounded in different pedagogical theories, they share essential attributes—namely, encouraging active participation and learner-centered involvement—which likely account for their consistent success in improving educational outcomes [28-33]. Likewise, the BOPPPS model (Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, Summary), which integrates structured instructional stages and includes pre- and post-testing, resembles the current study's framework. Research utilizing the BOPPPS method has also demonstrated that learner-centered strategies, where students assume an active role, are more effective than conventional teacher-led approaches [34-36].

Beyond nursing, learning by teaching has been effectively implemented in diverse fields such as foreign language education, science, and teacher training programs. In these areas, the method has proven to enhance not only subject comprehension but also essential transferable skills, including teamwork, communication, and critical thinking [22,27]. These outcomes indicate that the approach possesses wide interdisciplinary relevance and that insights from other disciplines could inform its adaptation to nursing education.

It is crucial, however, to differentiate learning by teaching from similar methods like peer teaching. Although both promote active participation, learning by teaching requires students to design the full instructional process—from planning and material preparation to content delivery—thus fostering deeper pedagogical engagement than simply explaining topics to classmates [21,37].

The observed effect sizes in this study suggest that the improvements achieved are not only statistically significant but also practically meaningful. Among the skill categories assessed, the smallest gains appeared in the IV administration group, while the most substantial advances were observed in the SC administration group. This pattern implies that the effectiveness of the learning-by-teaching approach may vary with the complexity or prior familiarity of the skill involved, warranting further research in this regard.

In today's educational context, nursing students must develop competencies to address complex, real-world healthcare challenges [38,39]. Therefore, nursing curricula should incorporate student-centered strategies that nurture analytical reasoning, creativity, and problem-solving, moving beyond traditional didactic instruction [40]. This investigation represents the first study in Türkiye to apply and evaluate the learning-by-teaching model within nursing education, marking a significant step toward expanding innovative pedagogical practices in the field.

Limitations

Despite the notable strengths of this research, several limitations should be acknowledged. The study was carried out at a single institution and lacked a randomized control group, which restricts the generalizability of its outcomes. The absence of a control group, in particular, represents a key methodological limitation. Additionally, because the OSCE assessments were administered by the researchers within the nursing faculty laboratories, potential evaluator bias may have influenced some results. As this investigation represents the first attempt to assess the learning-by-teaching approach in nursing education, the discussion necessarily relied on comparisons with other active learning models. These constraints should be carefully considered when designing future research in this area. Nevertheless, the study makes significant contributions—it is the first to examine this instructional model in nursing education, provides empirical evidence supporting its effectiveness for skills training, and introduces a novel pedagogical strategy to the discipline.

Conclusion

This study demonstrated that the learning-by-teaching strategy effectively enhances nursing students' theoretical understanding and practical competencies. Beyond confirming its positive impact, the findings emphasize that this approach promotes engagement, accountability, and deeper comprehension—qualities that align with the goals of modern nursing education. The results indicate that learning by teaching could be systematically incorporated into nursing programs, particularly within skills laboratories and clinical instruction, to better equip students for the challenges of complex healthcare settings. Future investigations should further evaluate this method across a broader range of nursing skills and institutional contexts, employing larger, more diverse samples and rigorous controlled or longitudinal research designs.

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References

1. Honey M, Collins E, Britnell S. Education into policy: embedding health informatics to prepare future nurses—New Zealand case study. JMIR Nurs. 2020;3(1):e16186. https://doi.org/10.2196/16186.
2. Hanbay O. The effect of quantum learning based learning by teaching method on learning German as a second foreign Language. Dicle Univ Ziya Gökalp Fac Educ J. 2009;(12):17–27.
3. Serindag E. The effect of 'Learning by teaching' method in Teaching/Learn- ing German as a second foreign Language. Cukurova Univ Fac Educ J. 2007;3(33):36–42.
4. Grzega J, Schöner M. The didactic model LdL (Lernen durch Lehren) as a way of Preparing students for communication in a knowledge society. J Educ Teach. 2008;34(3):167–75. https://doi.org/10.1080/02607470802212157.
5. Temel S. Learning by teaching approach. In: Ekici G, editor. Current Learning- Teaching approaches with activity Examples-IV. Ankara: Pegem Academy; 2020.
6. Ahmed AGA. The impact of learning by teaching strategy on university students' linguistic competence. Univ Bakht Alruda Sci J. 2013;9:185–200. htt ps://doi.org/10.5926/jjep.57.86.
7. Aslan S. The effect of learning by teaching on Pre-Service science teachers' attitudes towards chemistry. J Turk Sci Educ. 2017;14(3):1–15. https://doi.org/ 10.12973/tused.10201a.
8. Grzega J, Klüsener B. Learning by teaching through polylogues: training expert communication in information and knowledge societies using LdL (Lernen durch Lehren). Fachsprache. 2011;33(1–2):17–35. https://doi.org/10.2 4989/fs.v33i1-2.1379.

9. Mannino JE, Cotter E. Educating nursing students for practice in the 21st century. Int Arch Nurs Health Care. 2016;2(1). https://doi.org/10.23937/2469-5 823/1510026.
10. National Research Council. Assessing 21st century skills: summary of a work- shop. Washington, DC: National Academies; 2011.
11. Aslan S. Learning by teaching: can it be utilized to develop inquiry skills? J Educ Train Stud. 2017;5(12):190–8. https://doi.org/10.11114/jets.v5i12.2781.
12. Berman A, Snyder SJ, Kozier B, Erb GL, Levett-Jones T, Dwyer T, et al. Kozier & Erb's fundamentals of nursing. Australian edition. Volume 3. Pearson Higher Education AU; 2014.
13. Craven RF, Hirnle CJ, Sharon J, editors. Fundamentals of nursing: human health and functions. İstanbul: Palme Publishing; 2015.
14. Crisp J, Douglas C, Rebeiro G, Waters D. Potter & Perry's fundamentals of nurs- ing. ANZ edition-eBook. Elsevier Health Sciences; 2020.
15. Potter PA, Perry AG, Stockert PA, Hall AM. Fundamentals of nursing. 8th ed. St Louis: Mosby Company; 2013.
16. Denat Y, Tuğrul E. A method for evaluating clinical skill performances: objec- tive structured clinical exams. J Educ Res Nurs. 2012;9(3):53–9.
17. Türk G, Denat Y. Basic skills in nursing care. 1st ed. Istanbul: Academy; 2017.
18. Duran D. Learning-by-teaching. Evidence and implications as a pedagogical mechanism. Innov Educ Teach Int. 2017;54(5):476–84. https://doi.org/10.1080/14703297.2016.1156011.
19. Fiorella L, Mayer RE. The relative benefits of learning by teaching and teach- ing expectancy. Contemp Educ Psychol. 2013;38(4):281–8. https://doi.org/10. 1016/j.cedpsych.2013.06.001.
20. Kobayashi K, Interactivity. A potential determinant of learning by Preparing to teach and teaching. Front Psychol. 2019;9:2755. https://doi.org/10.3389/fpsyg.2018.02755.
21. Pierce B, van de Mortel T, Allen J, Mitchell C. The influence of near-peer teach- ing on undergraduate health professional students' self-efficacy beliefs: A systematic integrative review. Nurse Educ Today. 2024;143:106377. https://doi.org/10.1016/j.nedt.2024.106377.
22. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wender- oth MP. Active learning increases student performance in science, engineer- ing, and mathematics. Proc Natl Acad Sci U S A. 2014;111(23):8410–5. https:// doi.org/10.1073/pnas.1319030111.
23. Fiorella L, Mayer RE. Role of expectations and explanations in learning by teaching. Contemp Educ Psychol. 2014;39(2):75–85. https://doi.org/10.1016/j. cedpsych.2014.01.001.
24. Ribosa J, Duran D. Student-generated teaching materials: a scoping review mapping the research field. Educ Knowl Soc. 2022;23:27443. https://doi.org/1 0.14201/eks.27443.
25. Stollhans S. Learning by teaching: Developing transferable skills. In: Corradini E, Borthwick K, Gallagher-Brett A, editors. Employability for Languages: A Handbook. 2016;161-4. https://doi.org/10.14705/rpnet.2016.cbg2016.478
26. Fiorella L, Mayer RE. Learning as a generative activity. Cambridge: Cambridge University Press; 2015.
27. Stone R, Cooper S, Cant R. The value of peer learning in undergraduate nurs- ing education: a systematic review. ISRN Nurs. 2013;2013:930901. https://doi. org/10.1155/2013/930901.
28. Cant RP, Cooper SJ. Use of simulation-based learning in undergraduate nurse education: an umbrella systematic review. Nurse Educ Today. 2017;49:63–71. https://doi.org/10.1016/j.nedt.2016.11.015.
29. Chang HY, Wu HF, Chang YC, Tseng YS, Wang YC. The effects of a virtual simulation-based, mobile technology application on nursing students' learn- ing achievement and cognitive load: randomized controlled trial. Int J Nurs Stud. 2021;120:103948. https://doi.org/10.1016/j.ijnurstu.2021.103948.
30. Li C, He J, Yuan C, Chen B, Sun Z. The effects of blended learning on knowl- edge, skills, and satisfaction in nursing students: A meta-analysis. Nurse Educ Today. 2019;82:51–7. https://doi.org/10.1016/j.nedt.2019.08.004.
31. Kurt Y, Öztürk H. The effect of mobile augmented reality application devel- oped for injections on the knowledge and skill levels of nursing students: an experimental controlled study. Nurse Educ Today. 2021;103:104955. https://d oi.org/10.1016/j.nedt.2021.104955.
32. Forbes H, Oprescu FI, Downer T, Phillips NM, McTier L, Lord B, et al. Use of videos to support teaching and learning of clinical skills in nursing education: A review. Nurse Educ Today. 2016;42:53–6. https://doi.org/10.1016/j.nedt.201 6.04.010.
33. Erdem DT, Bahar A. The learning effects of flipped classroom model on nurs- ing student's vital signs skills: a quasi-experimental study. Istanbul Gelisim Univ J Health Sci. 2022;17470–84. https://doi.org/10.38079/igusabder.106620 1.
34. Li Y, Li X, Liu Y, Li Y. Application effect of BOPPPS teaching model on funda- mentals of nursing education: a meta-analysis of randomized controlled studies. Front Med (Lausanne). 2024;11:1319711. https://doi.org/10.3389/fme d.2024.1319711.

35. Shen Y. The application of the BOPPPS model in the ward rounds of nurses' standardized training in Southwest china: a mixed methods study. Front Med (Lausanne). 2024;11:1276652. https://doi.org/10.3389/fmed.2024.1276652.
36. Wen H, Xu W, Chen F, Jiang X, Zhang R, Zeng J, et al. Application of the BOPPPS-CBL model in electrocardiogram teaching for nursing students: a randomized comparison. BMC Med Educ. 2023;23(1):987. https://doi.org/10.1 186/s12909-023-04983-x.
37. Oermann MH, Reynolds SS, Granger BB. Using an implementation science framework to advance the science of nursing education. J Prof Nurs. 2022;39(Mar–Apr):139–45. https://doi.org/10.1016/j.profnurs.2022.01.014.
38. Lee K. Autoethnography as an authentic learning activity in online doctoral education: an integrated approach to authentic learning. TechTrends. 2020;64(4):570–80. https://doi.org/10.1007/s11528-020-00508-1.
39. Yancey NR. Why teach nursing theory? Nurs Sci Q. 2015;28(4):274–8. https://doi.org/10.1177/0894318415599234.
40. Venvertloh BL. Current perspectives on the gestalt of nursing curriculum [dissertation]. St Louis (MO): ProQuest Dissertations & Theses Global; 2019. Available from: https://www.proquest.com/dissertations-theses/current-pers pectives-on-gestalt