



The Effect of Team-based Training Through Smartphone Applications on Nursing Students' Clinical Skills and Problem-Solving Ability

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Received 2021 March 06; Revised 2021 November 19; Accepted 2021 December 16.

Abstract

Background: The aim of this study was to determine the effect of a team-based educational program through smartphone applications on Iranian nursing students' problem-solving ability and clinical skills.

Methods: This quasi-experimental study with two groups, including an experimental and a control group, was conducted among 60 nursing students who spent internship period in post CCU and CCU wards for 16 weeks. The control group received routine training, and the students of the experimental group received a team-based program through a smartphone application in addition to routine training. Students involved in the program were invited to complete the clinical skills questionnaire and Heppner's Problem-Solving Inventory at baseline and week four, and week 12 of follow-up. Data were analyzed using SPSS software (Version 22).

Results: A significant improvement was found in nursing students' clinical skills and problem-solving ability at week four and week 12 of follow-up compared with baseline ($P < 0.001$). However, the mean scores increased more in the experimental group.

Conclusions: This study suggests that team-based training through smartphone applications can enhance problem-solving perception and clinical skills in nursing students. It is expected that in the future, team-based training through smartphone applications may be used in the internship training of nursing students continuously.

Keywords: Education, Students, Nursing, Problem-Solving, Clinical Competence

1. Background

Although the main purpose of nursing education is to reduce the gap between theoretical concepts and clinical practice, many nursing students with a good theoretical background do not have sufficient skills in the clinical environment and cannot use problem-solving skills for creative performance (1, 2). Problem-based learning (PBL) is a structured, student-centered and active strategy that can help students apply science and skills in new situations (3). The PBL strategy promotes students' learning and helps them solve real-life problems by seeking scientific information (4). According to the literature, the concurrence of using PBL with team-based learning (TBL) is more effective (5, 6).

TBL engages students in goal setting and problem-solving (7). So, the audience actively participates in the learning process instead of inactive presence in teacher-centered methods (8). This strategy increases students' in-

terest in team working, and enhances their critical thinking (9). Time constraints, the difficulty of team management, and the lack of participation of shy students in the discussion have been listed as the disadvantages of team-based learning; however, they can be solved using virtual social networks (10). Today, there is great potential for using collaborative web platforms that allow online groups to be created, and health ideas, advice, and experiences can be shared (11).

For example, researchers indicated the use of Twitter has been successful to disseminate public health and emergency information and predict disease outbreaks (12, 13). Free et al. stated smartphones and apps have promising and exciting roles in enhancing medical education, patient care, and communication (14). Other authors confirmed that smartphones enhance the nursing students' knowledge and practice by sending video anytime and anywhere (15). Also, the usefulness of educational video clips

to improve communication skills and emotional intelligence, and clinical competence were confirmed in a quasi-experimental study (16). For the last case, we can mention a study in Iran that pointed out the positive effect of virtual education on students' metacognitive self-regulation as well as attitudes (17).

All of these studies showed that using new teaching methods and technologies can help to better outputs in education aspects. However, it is necessary to do more researches. To the best of our knowledge, there was not a study that measured the impact of team-based education on clinical skills and problem-solving perception through social networking apps in nursing students. Therefore, our study is the first one that investigated the effect of virtual team-based education on the acquisition of clinical skills and problem-solving skills in nursing students.

2. Methods

2.1. Study Design

It was a quasi-experimental study with pretest-posttest design that investigated the effect of implementing a team-based educational program through virtual social networking apps on nursing students' clinical skills and problem-solving ability in Fasa University of Medical Science, Fasa, Iran.

2.2. Participants

The inclusion criteria for the participants were being a nursing student who did not pass the Post CCU and CCU Internships, having a smartphone, and willingness to participate in the study. Exclusion criteria included non-attendance at all training sessions and current psychological symptoms that may impair participants' attendance in training sessions and assessment. The total sample size was calculated to be 60 participants according to the 95% confidence interval, 80% test power, and 0.8 effect size in the study of Naderi et al. (17) with a 20% attrition rate. Then, 30 participants were assigned to each group by a convenience sampling method.

2.3. Intervention

The educational content was selected according to the nursing internship curriculum in the CCU and post-CCU wards, which includes all emotional, cognitive, and psychomotor domains. Students in the control group received only routine training. Students in the experimental group received team-based learning in addition to routine training, they were also members of Telegram groups that had access to training online. The Telegram group was

created due to students could access educational materials at any time and share what they had learned. Team-based learning (TBL) steps in the experimental group are displayed in Table 1 in detail. This training included the following:

(1) Emotional domain: Teaching effective methods of communication with classmates, the patient, and his family and supporting the patient to make decisions about treatment and self-care.

(2) Cognitive domain: Identifying and diagnose critical situations and selecting appropriate solutions to deal with these situations.

(3) Psychomotor domain: Suitable clinical performance in different conditions and working with the devices and equipment available in the ward.

2.4. Study Instruments

According to the purpose of the study, three forms were used to collect data, the first part of which included a demographic data form (age, sex, marital status). The second part was a 17-item researcher-made questionnaire that measured clinical skills, and the third part was the 35-choice Heppner's Problem-Solving Inventory (P.S.I.) (18).

The clinical skills questionnaire is evaluated students' clinical performance in three domains of learning related to special cardiac wards including cognitive, affective, and psychomotor. Cognitive domain questions include recognizing the symptoms of heart disease, diagnosing common heart dysrhythmias, and planning for patient care. Items of affective domain included meeting the patient's emotional needs, the ability to communicate effectively with the patient, and self-confidence in doing performance. The psychomotor domain's questions included doing proper nursing care, working with various devices in the ward, and following up the patients' needs. The content validity of the clinical skill questionnaire was calculated by the content validity index using the opinions of 10 faculty members, the value of which was 88%. The reliability of this questionnaire was confirmed using Cronbach's alpha coefficient, and 0.89 was achieved. Clinical skill questionnaire items were scored on a Likert scale from 1 to 5 (strongly disagree 1, relatively disagree 2, no comment 3, relatively agree 4, strongly agree 5) with a scoring range of 17 to 85.

Heppner's Problem-Solving Inventory has been used in various studies and has shown acceptable reliability in independent samples and different cultural groups (19, 20). This tool includes three factors of problem-solving confidence, approach-avoidance style, and the factor of personal control (18). In this study, the content validity of this questionnaire was determined by the content validity index using the opinions of 10 faculty members, the

Table 1. Team-based Learning (TBL) Steps in the Experimental Group in Detail

	Goals	Content	Teaching Methods
Phase 1			
Pre-class study	Preparation	The topic of each session according to the education curriculum was provided to the students, and the student was required to review the topics before the start of the class and get prepared. On the first day of the internship, groups of three were formed, and students in each group were asked to make a video on how to use medical equipment and issues in the CCU ward and to set them in the telegram group according to schedule.	Student-centered; cooperative learning
Phase 2			
Individual readiness assurance test (iRAT)	Diagnosis; feedback	At the beginning of every internship day, an individual test was taken from all students based on educational content in every day.	Inquiry-based learning; cooperative learning
Team readiness assurance test (tRAT)		Immediately after the individual tests, students were asked to take the same test as a group. Questions were asked in the telegram group, and students shared their answers.	
Team appeals		Students were allowed to refer to the book about their arguments and leave their answers in the form of text, photos, or videos in the telegram group and request an appeal of their answers.	
Feedback		The instructor provided feedback to the students, and further controversial questions were discussed. The instructor showed feedback to the students both through the web and in the ward.	
Phase 3			
Application-oriented activity	Application of course concepts	Putting case-based scenarios in the Telegram group for increasing opportunity to discuss among groups, share the best diagnosis, treatment, or care by students to improve problem-solving skills in them.	Cooperative learning; problem-solving learning

value of which was estimated at 86%. The Cronbach's alpha coefficient was 0.93 for the whole Problem-Solving Inventory, 0.85 for the problem-solving confidence factor, 0.89 for the factor of approach-avoidance style, and 0.73 for the personal control factor. This Questionnaire's items were graded on a Likert scale from 1 to 5 (strongly disagree 1, relatively disagree 2, no comment 3, relatively agree 4, strongly agree 5), and the score range was 35 to 175.

2.5. Data Collection and Analysis

At first, the questionnaires were given to the trainee students of the two intervention and control groups. While the control group routinely learned the necessary skills in PCCU and CCU, the intervention group also joined the Telegram online training group and received the training intervention in addition to routine training for four consecutive weeks. Follow-up data were also collected 12 weeks later. The interventions were designed so that it was not possible to communicate between the intervention and control groups at the time of the educational intervention. SPSS software version 24 was used for data analysis. A repeated measurement test was used to determine

the difference in scores between the three periods at baseline and week four, and week 12 follow-ups, and paired *t*-test was used to analyze the differences between the groups.

3. Results

The participants included sixty nursing students (30 in the intervention group and 30 in the control group). Their average age was 21 ± 0.9 years. In the intervention group, there were 17 female and 13 male students, of which only three were married. In the control group, there were 16 female and 14 male students.

Independent *t*-test did not show a significant difference between the experimental and control groups in terms of problem-solving skills and clinical skills before the intervention, and the two groups were identical in terms of these variables (Table 2).

In order to determine the effect of team-based training on problem-solving perception and clinical skills, a repeated measurement test was used, and the results showed that training caused a significant difference in total scores of clinical skills and problem-solving perception in the ex-

Table 2. Comparison Between Mean Scores of Problem-Solving and Clinical Skills Before Intervention in Interventional and Control Groups^a

Variables	Mean ± SD	Levene's Test		t-test		
		F	P-Value	t	df	P-Value
Problem-Solving Inventory		0.513	0.477	-0.335	58	0.739
IG	99.66 ± 19.44					
CG	101.30 ± 18.27					
Clinical skills questionnaire		0.081	0.777	-0.292	58	0.771
IG	46.96 ± 7.95					
CG	47.60 ± 8.78					

Abbreviations: IG, interventional group; CG, control group.

^aSignificant at the level of $P < 0.05$.

perimental group at baseline and week four, and week 12 of follow-up (Table 3).

It is noteworthy that there was also a significant difference in the total score of clinical skills and problem-solving perception in the control group (Table 4). But the mean scores in the intervention group increased more than the control group (Figure 1).

Table 5 indicates changes of the mean and standard deviation of the dimensions of Problem-Solving Inventory and clinical skills across the intervention and control groups in the baseline, from baseline to week four, and from baseline to week 12. The analysis shows that the total score of the Problem-Solving Inventory in the intervention group is greater than that of the control group from baseline to week four and from baseline to week 12 and the problem-solving confidence, approach-avoidance style, personal control for the intervention group is significantly greater than that of the control group. Particularly, the approach-avoidance style for the control group from baseline to week four was not significant as compared to intervention group scores ($P = 0.389$). It was shown that the scores four weeks after the intervention were higher than the baseline, i.e., before the intervention, and the scores 12 weeks after the intervention were higher than the baseline scores; therefore, the scores of both columns were negative. The difference between scores of four weeks after the intervention and 12 weeks after the intervention was positive, which indicated a higher score of four weeks after the intervention. These changes also existed in the control group but to a lesser extent.

4. Discussion

The study demonstrated that significant improvements were created in nursing students' clinical skills

and problem-solving perceptions following virtual team-based training. The total score of the Problem-Solving Inventory and clinical skills of the intervention group was greater than that of the control group from baseline to week four and from baseline to week 12. This finding is consistent with the results of previous studies that have shown that team-based learning is an effective training strategy to increase problem-solving ability and improve clinical performance in nursing students (16, 21, 22). On the other hand, other researchers confirm a blended learning model, which includes online video resources, is a beneficial tool for teaching clinical skills to nursing students that not only strengthens students' knowledge and skills but also students can practice multiple times without worrying about mistakes in a non-judgmental learning environment (23-25). Mettinen et al. explained that nursing students in the web-based groups shared their knowledge and experience, and progress in the clinical learning process simultaneously with each other by reflecting on their own experiences and those of others (26).

The present study also revealed that changes in approach-avoidance style, one dimension of problem-solving, were not significant in week four in the control group. This finding showed that routine training in week four had no effect on how to deal with the problem in the students in the control group. While students who have received team-based training through a smartphone application used the approach method when dealing with a problem and did not avoid facing a problem because consensus and sharing information in the virtual team has solved problems and answered questions in the shortest possible time. Burgess et al. believe that medical students in team-based learning have the opportunity to solve problems together and learn different perspectives on a patient (27). It seems that the way of dealing with problems in the students of the control group has not changed due to due

Table 3. Comparison of Problem-Solving and Clinical Skills in Nursing Students in Baseline, Week Four, and Week 12 in the Intervention Group ^{a, b}

	Baseline	Week 4	Week 12	Repeated Measurement ANOVA (Intra Group Differences)					
				Mauchly's W	df	P-Value	Greenhouse-Geisser	F	P-Value
Problem-Solving Inventory (total)	99.66 ± 19.44	149.03 ± 7.24	113.76 ± 10.96	0.778	2	0.03	0.718	94.26	< 0.001
Problem-solving confidence	31.80 ± 5.47	46.96 ± 3.02	35.16 ± 4.08						
Approach-avoidance style	46.40 ± 10.87	67.46 ± 4.36	52.16 ± 5.84						
Personal control	13.33 ± 2.72	21.70 ± 1.41	16.76 ± 2.38						
Clinical skills questionnaire	46.96 ± 7.95	69.03 ± 4.28	54.66 ± 5.95	0.665	2	0.003	0.749	146.97	< 0.001

^aValues are expressed as mean ± SD.

^bSignificant at the level of P < 0.05

Table 4. Comparison of Problem-Solving and Clinical Skills in Nursing Students in Baseline, Week Four, and Week 12 in the Control Group ^{a, b}

	Baseline	Week 4	Week 12	Repeated Measurement ANOVA (With In-group Differences)					
				Mauchly's W	df	P-Value	Greenhouse-Geisser	F	P-Value
Problem-Solving Inventory (total)	101.30 ± 18.27	133.86 ± 8.02	109.23 ± 8.43	0.778	2	0.002	0.730	53.62	< 0.001
Problem-solving confidence	31.43 ± 6.80	41.73 ± 3.21	35.33 ± 2.90						
Approach-avoidance style	47.63 ± 10.87	61.23 ± 4.45	48.86 ± 5.11						
Personal control	14.50 ± 3.31	19.60 ± 2.72	15.16 ± 2.16						
Clinical skills questionnaire	47.60 ± 8.78	61.90 ± 8.11	51.30 ± 8.34	0.343	2	< 0.001	0.604	57.17	< 0.001

^aValues are expressed as mean ± SD.

^bSignificant at the level of P < 0.05

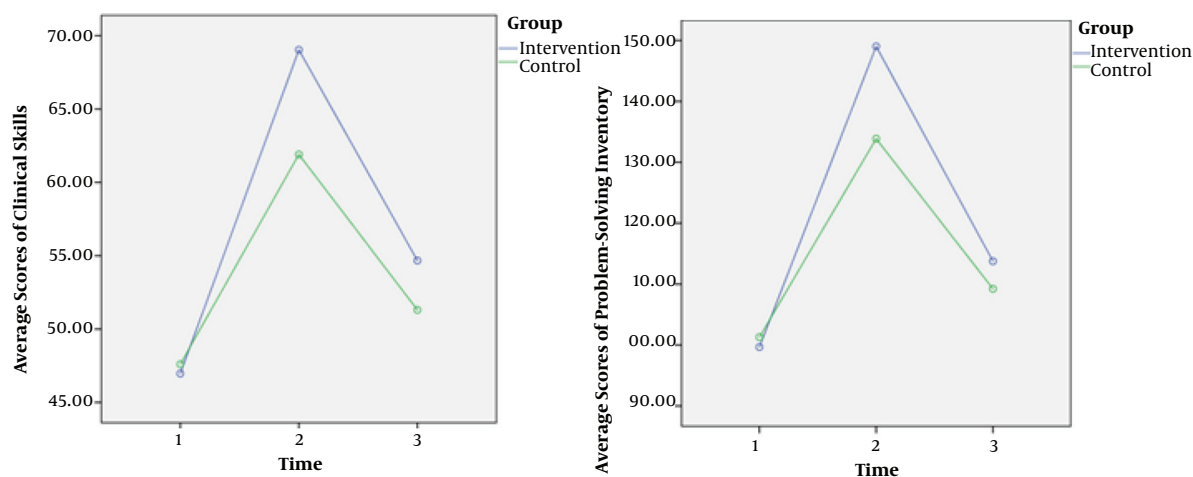


Figure 1. Average scores of clinical skills and Problem-Solving Inventory in the experimental and control groups

Table 5. Changes (Mean \pm Standard Deviation) Between the Groups on Dimension of Problem-Solving Inventory, and Clinical Skills Questionnaire ^{a, b}

Variables	Change from Baseline to Week 4	Change from Baseline to Week 12	Change from Week 4 to Week 12
Problem-solving confidence			
IG	-15.16 \pm 6.66	-3.36 \pm 6.23	11.80 \pm 5.40
P-value	< 0.001	0.006	< 0.001
CG	-10.30 \pm 8.03	-3.90 \pm 7.25	6.40 \pm 3.81
P-value	< 0.001	0.006	< 0.001
Approach-avoidance style			
IG	-21.06 \pm 13.17	-5.76 \pm 13.03	15.30 \pm 7.63
P-value	< 0.001	0.022	< 0.001
CG	13.60 \pm 11.60	-1.23 \pm 10.03	12.36 \pm 7.49
P-value	< 0.001	0.389	< 0.001
Personal control			
IG	-8.36 \pm 2.98	-3.43 \pm 3.43	4.93 \pm 2.97
P-value	< 0.001	< 0.001	< 0.001
CG	-5.10 \pm 4.46	-0.66 \pm 4.17	4.43 \pm 3.84
P-value	< 0.001	< 0.001	< 0.001
Total score of Problem-Solving Inventory			
IG	-49.36 \pm 22.95	-14.10 \pm 22.11	35.26 \pm 14.78
P-value	< 0.001	< 0.001	< 0.001
CG	-32.56 \pm 21.81	-7.93 \pm 18.76	24.63 \pm 11.82
P-value	< 0.001	0.028	< 0.001
Total score of the clinical skills questionnaire			
IG	-22.06 \pm 8.94	-7.70 \pm 5.54	14.36 \pm 6.55
P-value	< 0.001	< 0.001	< 0.001
CG	-14.30 \pm 9.59	-3.70 \pm 3.60	10.60 \pm 8.27
P-value	< 0.001	< 0.001	< 0.001

Abbreviations: IG, interventional group; CG, control group.

^aValues are expressed as mean \pm SD.

^bSignificant at the level of $P < 0.05$.

to the stress of entering a new learning environment and the lack of opportunity to interact and share information with each other.

According to the results, the follow-up scores of week 12 decreased compared to week four. This finding indicates that the changes in the problem-solving ability and clinical skills of nurses fade over time; therefore, it is recommended that student training should be continued in person or online. Based on Liu et al.'s study, nurses' knowledge and practice should be continuously developed, and that it is better to use smartphone training platforms to improve and sustain education (28).

A combination of routine clinical training and team-based training through smartphone applications is most

influential in the improvement of nursing students' clinical skills and problem-solving ability compared with routine training alone. This training method in internships provides students with the opportunity to share their experiences and feelings and help each other learn, regardless of time or place. This method of teaching can create an environment away from judgment and encourage students to participate in improving the level of clinical performance of each other. It is suggested that in the future, team training through smartphone applications will be used continuously in nursing students' internship training.

Footnotes

Authors' Contribution: Mohadeseh Motamed-Jahromi conceptualized the study project; Mohadeseh Motamed-Jahromi and Seyedeh Leila Dehghani participated in developing the study, education, data gathering, data analysis, and writing of the manuscript. Fateme Eshghi contributed to developing the educational plan. Zahra Meshkani and Tayebeh Jalali helped in education and editing the manuscript. Fatemeh Dadgar and Elham NejadSadeghe contributed to the interpretation of data. All authors read and approved the final manuscript.

Conflict of Interests: The authors declare that there is no conflict of interest regarding the publication of this article.

Ethical Approval: This research was carried out within the framework of the approved project No. 93144 at Vice-Chancellery for Research and Technology in Fasa University of Medical Sciences with IR.FUMS.REC.1395.87 code of research ethics.

Funding/Support: Fasa University of Medical Sciences has only sponsored. The funder had no role in design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

Informed Consent: The permission of the hospital managers and students' informed consent was obtained. The objectives of the research were explained, and the confidentiality of information and anonymity of the questionnaires were emphasized, and it was tried that the time of completing the questionnaires did not interfere with the students' internship hours.

References

- Ashley J, Stamp K. Learning to think like a nurse: the development of clinical judgment in nursing students. *J Nurs Educ*. 2014;**53**(9):519-25. doi: [10.3928/01484834-20140821-14](https://doi.org/10.3928/01484834-20140821-14). [PubMed: [25199107](https://pubmed.ncbi.nlm.nih.gov/25199107/)].
- Wang JJ, Lo CH, Ku YL. Problem solving strategies integrated into nursing process to promote clinical problem solving abilities of RN-BSN students. *Nurse Educ Today*. 2004;**24**(8):589-95. doi: [10.1016/j.nedt.2004.07.004](https://doi.org/10.1016/j.nedt.2004.07.004). [PubMed: [15519441](https://pubmed.ncbi.nlm.nih.gov/15519441/)].
- Williams SM, Beattie HJ. Problem based learning in the clinical setting—a systematic review. *Nurse Educ Today*. 2008;**28**(2):146-54. doi: [10.1016/j.nedt.2007.03.007](https://doi.org/10.1016/j.nedt.2007.03.007). [PubMed: [17919784](https://pubmed.ncbi.nlm.nih.gov/17919784/)].
- Niemer L, Pfendt K, Gers M. Problem-based learning in nursing education: a process for scenario development. *Nurse Educ*. 2010;**35**(2):69-73. doi: [10.1097/NNE.0b013e3182ced891](https://doi.org/10.1097/NNE.0b013e3182ced891). [PubMed: [20173591](https://pubmed.ncbi.nlm.nih.gov/20173591/)].
- Corbridge SJ, Corbridge T, Tiffen J, Carlucci M. Implementing team-based learning in a nurse practitioner curriculum. *Nurse Educ*. 2013;**38**(5):202-5. doi: [10.1097/NNE.0b013e3182a0e416](https://doi.org/10.1097/NNE.0b013e3182a0e416). [PubMed: [23969749](https://pubmed.ncbi.nlm.nih.gov/23969749/)].
- Burgess A, Roberts C, Ayton T, Mellis C. Implementation of modified team-based learning within a problem based learning medical curriculum: a focus group study. *BMC Med Educ*. 2018;**18**(1):74. doi: [10.1186/s12909-018-1172-8](https://doi.org/10.1186/s12909-018-1172-8). [PubMed: [29631579](https://pubmed.ncbi.nlm.nih.gov/29631579/)]. [PubMed Central: [PMC5892039](https://pubmed.ncbi.nlm.nih.gov/PMC5892039/)].
- Medina MS, Conway SE, Davis-Maxwell TS, Webb R. The impact of problem-solving feedback on team-based learning case responses. *Am J Pharm Educ*. 2013;**77**(9):189. doi: [10.5688/ajpe779189](https://doi.org/10.5688/ajpe779189). [PubMed: [24249851](https://pubmed.ncbi.nlm.nih.gov/24249851/)]. [PubMed Central: [PMC3831400](https://pubmed.ncbi.nlm.nih.gov/PMC3831400/)].
- Jahng N, Bullen M. Exploring group forming strategies by examining participation behaviours during whole class discussions. *EURDL*. 2012;**15**(1).
- Ofstad W, Brunner LJ. Team-based learning in pharmacy education. *Am J Pharm Educ*. 2013;**77**(4):70. doi: [10.5688/ajpe77470](https://doi.org/10.5688/ajpe77470). [PubMed: [23716738](https://pubmed.ncbi.nlm.nih.gov/23716738/)]. [PubMed Central: [PMC3663624](https://pubmed.ncbi.nlm.nih.gov/PMC3663624/)].
- Van De Belt TH, Engelen LJ, Berben SA, Schoonhoven L. Definition of Health 2.0 and Medicine 2.0: a systematic review. *J Med Internet Res*. 2010;**12**(2). e18. doi: [10.2196/jmir.1350](https://doi.org/10.2196/jmir.1350). [PubMed: [20542857](https://pubmed.ncbi.nlm.nih.gov/20542857/)]. [PubMed Central: [PMC2956229](https://pubmed.ncbi.nlm.nih.gov/PMC2956229/)].
- Kitching F, Winbolt M, MacPhail A, Ibrahim JE. Web-based social media for professional medical education: Perspectives of senior stakeholders in the nursing home sector. *Nurse Educ Today*. 2015;**35**(12):1192-8. doi: [10.1016/j.nedt.2015.05.013](https://doi.org/10.1016/j.nedt.2015.05.013). [PubMed: [26072372](https://pubmed.ncbi.nlm.nih.gov/26072372/)].
- Ginsberg J, Mohebbi MH, Patel RS, Brammer L, Smolinski MS, Brilliant L. Detecting influenza epidemics using search engine query data. *Nature*. 2009;**457**(7232):1012-4. doi: [10.1038/nature07634](https://doi.org/10.1038/nature07634). [PubMed: [19020500](https://pubmed.ncbi.nlm.nih.gov/19020500/)].
- Holt C. Emerging Technologies: Web 2.0. *Health Inf Manag*. 2011;**40**(1):33-5. doi: [10.1177/183335831104000106](https://doi.org/10.1177/183335831104000106). [PubMed: [28683607](https://pubmed.ncbi.nlm.nih.gov/28683607/)].
- Free C, Phillips G, Watson L, Galli L, Felix L, Edwards P, et al. The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. *PLoS Med*. 2013;**10**(1). e1001363. doi: [10.1371/journal.pmed.1001363](https://doi.org/10.1371/journal.pmed.1001363). [PubMed: [23458994](https://pubmed.ncbi.nlm.nih.gov/23458994/)]. [PubMed Central: [PMC3566926](https://pubmed.ncbi.nlm.nih.gov/PMC3566926/)].
- George TP, DeCristofaro C. Use of Smartphones With Undergraduate Nursing Students. *J Nurs Educ*. 2016;**55**(7):411-5. doi: [10.3928/01484834-20160615-11](https://doi.org/10.3928/01484834-20160615-11). [PubMed: [27351612](https://pubmed.ncbi.nlm.nih.gov/27351612/)].
- Choi Y, Song E, Oh E. Effects of teaching communication skills using a video clip on a smart phone on communication competence and emotional intelligence in nursing students. *Arch Psychiatr Nurs*. 2015;**29**(2):90-5. doi: [10.1016/j.apnu.2014.11.003](https://doi.org/10.1016/j.apnu.2014.11.003). [PubMed: [25858200](https://pubmed.ncbi.nlm.nih.gov/25858200/)].
- Naderi F, Ayati M, Zare Bidaki M, Akbari Bourang M. [The effect of mobile learning on metacognitive self-regulation and attitudes of students of allied health sciences]. *Iran J Med Educ*. 2014;**13**(12):1001-10. Persian.
- Heppner P, Petersen CH. The development and implications of a personal problem-solving inventory. *J Couns Psychol*. 1982;**29**(1):66-75. doi: [10.1037/0022-0167.29.1.66](https://doi.org/10.1037/0022-0167.29.1.66).
- Kourmoussi N, Xythali V, Theologitou M, Koutras V. Validity and Reliability of the Problem Solving Inventory (PSI) in a Nationwide Sample of Greek Educators. *Social Sciences*. 2016;**5**(2). doi: [10.3390/socsci5020025](https://doi.org/10.3390/socsci5020025).
- Veysel T. The problem-solving skills of the teachers in various branches. *Educ Res Rev*. 2015;**10**(5):641-7. doi: [10.5897/err2014.2059](https://doi.org/10.5897/err2014.2059).
- Kim HR, Song Y, Lindquist R, Kang HY. Effects of team-based learning on problem-solving, knowledge and clinical performance of Korean nursing students. *Nurse Educ Today*. 2016;**38**:115-8. doi: [10.1016/j.nedt.2015.12.003](https://doi.org/10.1016/j.nedt.2015.12.003). [PubMed: [26740030](https://pubmed.ncbi.nlm.nih.gov/26740030/)].
- Kim S. Effects of Team-based Learning on Learning Attitude, Learning Motivation, Problem Solving Ability, Participation in Lessons of Nursing Students. *J Digit Converg*. 2017;**15**(4):351-63. doi: [10.14400/jdc.2017.15.4.351](https://doi.org/10.14400/jdc.2017.15.4.351).
- Coyne E, Rands H, Frommolt V, Kain V, Plugge M, Mitchell M. Investigation of blended learning video resources to teach health students clinical skills: An integrative review. *Nurse Educ Today*. 2018;**63**:101-7. doi: [10.1016/j.nedt.2018.01.021](https://doi.org/10.1016/j.nedt.2018.01.021). [PubMed: [29425738](https://pubmed.ncbi.nlm.nih.gov/29425738/)].
- McCutcheon K, O'Halloran P, Lohan M. Online learning versus blended learning of clinical supervisee skills with pre-registration nursing students: A randomised controlled trial. *Int J Nurs Stud*. 2018;**82**:30-9. doi: [10.1016/j.ijnurstu.2018.02.005](https://doi.org/10.1016/j.ijnurstu.2018.02.005). [PubMed: [29574394](https://pubmed.ncbi.nlm.nih.gov/29574394/)].

25. Pyo MY, Kim JY, Sohn JO, Lee ES, Kim HS, Kim KO, et al. The effects of an advanced cardiac life support training via smartphone's simulation application on nurses' knowledge and learning satisfaction. *J Korean Clin Nurs Res.* 2012;**18**(2):228–38.
26. Mettinen S, Vahamaa K. Does reflective web-based discussion strengthen nursing students' learning experiences during clinical training? *Nurse Educ Pract.* 2013;**13**(5):344–9. doi: [10.1016/j.nepr.2012.09.012](https://doi.org/10.1016/j.nepr.2012.09.012). [PubMed: [23116619](https://pubmed.ncbi.nlm.nih.gov/23116619/)].
27. Burgess A, Kalman E, Haq I, Leaver A, Roberts C, Bleasel J. Interprofessional team-based learning (TBL): how do students engage? *BMC Med Educ.* 2020;**20**(1):118. doi: [10.1186/s12909-020-02024-5](https://doi.org/10.1186/s12909-020-02024-5). [PubMed: [32306968](https://pubmed.ncbi.nlm.nih.gov/32306968/)]. [PubMed Central: [PMC7168950](https://pubmed.ncbi.nlm.nih.gov/PMC7168950/)].
28. Liu X, Cheng J, Huang S. Mobile Phone Training Platform for the Nursing Staff in the Emergency Department. *Telemed J E Health.* 2019;**25**(1):66–70. doi: [10.1089/tmj.2017.0317](https://doi.org/10.1089/tmj.2017.0317). [PubMed: [29742034](https://pubmed.ncbi.nlm.nih.gov/29742034/)].