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Evidence-based nursing education for undergraduate students: A preliminary experimental study

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ABSTRACT

With increasing needs for evidence-based practice, the well-designed EBP education is necessary to enhance the critical thinking and decision-making skills of nursing undergraduates. This study is to evaluate the effectiveness of an evidence-based practice education program with blended learning on undergraduate nursing students. In this preliminary experimental study, 45 senior nursing undergraduates were recruited from a university in Seoul, Korea. Self-selection was used to create two groups: an intervention group and a control group consisting of 21 and 24 students, respectively. The intensive 30-hours evidence-based practice education program was provided to the intervention group. Evidence-based practice knowledge, self-efficacy, and evidence utilization were evaluated as outcome variables at baseline and two months after the intervention. There were no significant differences between the intervention and control groups on the background characteristics and outcome variables ($p > .05$). There were significant increases in evidence-based practice knowledge ($Z = -5.28$), self-efficacy ($t = -6.42$), resource utilization ($Z = -2.60$), and databases utilization ($t = -2.98$) in the intervention group, when compared with the control group ($p < .01$). Further studies are recommended to develop the evidence-based practice train-the-trainer program for nursing educators and to maximize the effectiveness of utilizing blended learning in evidence-based practice education.

Evidence-based practice (EBP) is the core component to improve the quality of care and health outcomes, and various nursing educational institutions are making efforts to enhance student nurses' EBP competencies. However, EBP is a complex and nonlinear process (Melnyk et al., 2012), and each step of EBP requires different kinds of competency including knowledge, attitude, and behavior. This had led to the suggestion of utilizing different learning methods in EBP education to adequately undertake all five steps of EBP (Ilic et al., 2015).

A recent systematic review reported that several studies utilized and recommended the blended learning as the effective learning methodology for EBP education, however, emphasized the absolute need for the strongly well-designed studies regarding learning methods (Mccutcheon et al., 2015). Ensuring nursing students' EBP competency in clinical practice requires systematically tailored undergraduate EBP education that utilizes blended learning.

1. Introduction

The innovative healthcare system requires patient-centered care based on scientific evidence to achieve the high-quality care and efficiency. The Institute of Medicine (IOM) emphasizes EBP as one of the core competencies for healthcare providers, in which 90% of all clinical decisions are based on scientific evidence (Institute of Medicine, 2011). Global trends in nursing education have evidenced a paradigm shift from traditional models to outcome- or competency-based models. Furthermore, nursing educational institutions in various countries have proposed EBP as the key competency for nursing. Accordingly, they have invested efforts in enhancing the effectiveness of EBP curricula at the undergraduate nursing education level (American Association of College of Nursing, 2008; Korean Accreditation Board of Nursing Education, 2012).

The ultimate goals of EBP education at the undergraduate level is to prepare students for clinical, management, or educational leadership roles in health care through translating the best available evidence into practice. This will enable students to develop the knowledge and skills that are required to review and synthesize empirical literatures. Further, if necessary, they will be equipped to use these empirical findings to recommend changes in clinical practice (Malik et al., 2015; Kyriakoulis et al., 2016). The main contents of EBP education are formulating clinical questions in PICO (Participants, Intervention,

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Comparison, and Outcome)s framework, searching evidence, critical appraisal of evidence, and application of findings into clinical practice (Malik et al., 2015). These EBP contents can be handled not only as stand-alone courses throughout the four years of the undergraduate curriculum but also as integrated with related courses (Moch et al., 2010; Ferwana et al., 2012). These academic efforts can foster nursing students to be competent in generating and consuming scientific evidences in clinical practice.

Moreover, EBP education is a challenge for undergraduate students because it requires a complex and non-linear progress. Indeed, EBP requires students to have well-rounded knowledge, attitudes, and skills to transform actual patient cases into clinical questions into PICO format that need to be addressed scientifically. Students feel anxiety about the complexity of clinical situation and the gaps between theory and practice (Johnson et al., 2010). Therefore, traditional teacher-centered learning methods are limited when teaching EBP; other innovative learning methods should be utilized in EBP education to meet students' needs (Hosny and Ghaly, 2014; Kyriakoulis et al., 2016). Many educators have attempted to adopt diverse pedagogical strategies into EBP nursing education for nursing undergraduates; this has helped students to integrate nursing knowledge and clinical practice together, which is the core goal of EBP (Aglen, 2016).

Fineout-Overholt et al. (2008) reported that the use of Team-Based Learning (TBL) or Problem-Based Learning (PBL) improves students' preparation, engagement, accountability, teamwork, inquiry, critical thinking, and learning outcomes. A recent systematic review reported that lectures, group activities with small group discussions, supervision of projects, hands-on work practice, and poster presentations were the most frequently used methods for EBP education (Haggman-Laitila et al., 2016). Several studies have recommended multifaceted learning methods as the promoting factors of EBP and research utilization. In Davidson and Candy (2016), a game-based learning method used in EBP education maximized student satisfaction of learning EBP and changed their attitude toward nursing research as fun. However, each learning method has its pros and cons with respect to teaching pre-healthcare professionals. Therefore, it is important to adopt appropriate methods matching EBP contents to improve their understanding and to achieve learning outcomes.

Self-directed learning (SDL) is emphasized in nursing education to increase students' confidence in their own ability and capacity. The blended learning approach is a new hybrid SDL strategy that not only systematically integrates both face-to-face and web-based engagement but also accommodates the different learning styles and requirements of students (O'Byrne and Pytash, 2015; Boyle et al., 2010). In blended learning classes, students and educators actively interact and engage with each other in order to confront complex thinking tasks and conduct problem-solving activities (Bergmann and Sams, 2012). These learning environments can improve student participation, assignment submission, and learning outcomes by placing significance on student spontaneity (Aglen, 2016). EBP requires concrete knowledge across the disciplines (e.g., pathophysiology, informatics, statistics, etc.); conversely, each discipline requires different learning strategies in EBP education (Masie, 2002; Grasl et al., 2012).

Therefore, an efficient EBP education with blended learning can be an alternative approach to enhance nursing undergraduate students' level of EBP competencies and increase their interest in learning EBP. The purpose of this study is to evaluate the effects of an EBP education utilizing blended learning on EBP knowledge, self-efficacy, and evidence utilization among undergraduate nursing students.

2. Method

2.1. Study design

This study used a non-randomized control group pretest–posttest design.

2.2. Study participants

Study participants were 45 senior undergraduate nursing students (among 82 senior students) of a university in South Korea, and convenience sampling method was used. The inclusion criteria were students who were enrolled in the regular nursing curriculum with no EBP course, have taken the regular junior undergraduate clinical nursing practicum, and who volunteered to participate in the study. The exclusion criteria were students who transferred from other schools or who had declared a double major. The sample size was calculated using the G*Power 3.1 software program and the following specifications: a power level of 0.80, a small to medium effect size of 0.40, and a significance level of 0.05. The effect size (i.e., Cohen's *d*) was considered based on the findings of a previous study (Yuan et al., 2008; Cohen, 1992). Although 48 students were initially recruited, three students dropped out (one from the intervention group and two from the control group) during the study. The final sample size (i.e., 45) had sufficient statistical power to detect significant trends in the data.

2.3. Intervention: EBP education program

The EBP education program was developed by the authors based on the ADDIE (Analysis-Design-Development-Implement-Evaluation) model, and the final program contents are shown in Table 1. A systematic literature review was conducted to extract the core concepts of EBP education. Then, the derived core concepts were compared with the contents of EBP-related courses including nursing research, nursing statistics, clinical nursing practicum, nursing informatics, and nursing ethics. A draft of the program was matched with blended learning methods including lecture, Team-based Learning (TBL) with flipped learning, Computer-based Learning (CBL), Problem-based Learning (PBL), and a group project with student presentations. Two EBP professionals, a school librarian and a clinical expert, were invited to deliver special lectures on topics related to searching for empirical evidence and translating evidence into practice. Students were introduced to electronic databases such as PubMed, Cumulative Index to Nursing & Allied Health Literature [CINAHL], and PsycINFO that can be used to search and retrieve empirical literature. As a part of the EBP group project, students were presented with five clinical scenarios that had

Table 1
Contents of EBP education program.

Credits	3 credits
Related courses	nursing research, nursing statistics, clinical nursing practicum, nursing informatics, and nursing ethics
Main contents	- Introduction of EBP, steps of EBP, defining clinical questions - Finding evidence: literature searching strategies - Critical appraisal of the evidence: study design and level of evidence - Translating evidence into practice, evaluating outcomes of EBP, understanding of nursing sensitive outcomes - EBP actions in hospital, barriers and facilitators of EBP
Teaching methods	Lectures (include special lectures from school librarian and clinical expert), Team-based Learning (TBL) with flipped learning, Computer-based Learning (CBL), Problem-based Learning (PBL), group activity with student presentation
Duration	30 hours (excluding midterm and final examination)

been developed from the clinical data about the health problems that have higher age- and gender-specific prevalence rates. These included diabetes mellitus (adult/men), congestive renal failure (adult/women), chronic heart failure (adult/men), acute myocardial infarction (adult/men), asthma (children-adolescent), and dementia (older adult) cases. Each group of students used the Patient, Intervention, Comparison, and Outcome (PICO) framework to define scenario-specific clinical questions and performed 5 steps of EBP (Melnyk and Fineout-Overholt, 2015).

The expert validity test was performed for program contents by nursing professionals (six nursing professors and four clinical nurse managers). The panel of experts was asked to rate the relevance of each item (i.e., learning outcomes, contents, and learning methods), using a 4-point scale ranging from "not relevant," which was assigned a score of 1, to "very relevant," which was assigned a score of 4. The four ordinal responses were categorized into two groups: 1 and 2 were categorized as "not relevant," whereas 3 and 4 were categorized as "relevant." Finally, the proportion of experts who considered the item to be relevant was calculated using the item-level content validity index (I-CVI). The average I-CVI in this study was 0.98, which is higher than 0.80, thereby supporting the validity of the program contents (Polit and Beck, 2008). The user validity test of the clinical scenarios was done by 12 nursing newly graduates; they were presented with five clinical scenarios and required to define PICOs. The level of difficulties and understanding of the five clinical scenarios were tested by assessing the time for defining PICOs; the average time was 9.6 min, and accuracy was 75.0%. As a next step, focus group interviews were conducted with 12 students to explore the comprehensibility, prerequisites, resources, and necessity of the EBP education. In general, most students endorsed the comprehensibility of the EBP education; however, some students reported a perceived lack of knowledge on clinical nursing interventions and evidence-searching strategies. In addition, students expressed that blended learning method motivated them to concentrate in EBP activities and improved their ability to implicate EBP in nursing practice. After some minor revisions to the draft, the final EBP education program was developed.

2.4. Instrumentation

The self-administered questionnaire has been designed by combining three reliable and valid instruments that measure the level of EBP knowledge, EBP self-efficacy, and evidence utilization (e.g., resources, database). Further, 13 items that measure the background characteristics (i.e., demographic and research-related characteristics) of study participants were included. Specific details on the outcome variables that were assessed in this study are as follows.

2.4.1. Level of EBP knowledge

This study utilized the Knowledge of Research Evidence Competencies (K-REC) instrument (Lewis et al., 2011), developed for evaluating health and medical students' cognitive skills related to EBP and for measuring participants' detailed knowledge of each step of EBP. The instrument consisted of a total of nine items; for example, "Compose a concrete clinical question for a literature search." Each item was scored on a scale ranging from 0.5 to 2 points, based on K-REC assessment guidelines; the sum of the individual item scores yielded the total score. Possible scores ranged from 0 to 12; higher scores were considered to have a higher level of EBP knowledge. The Intraclass Correlation Coefficient (ICC) of the inter-rater assessment, at the time of scale development, was .88; this value indicates that the instrument has sufficient reliability (Lewis et al., 2011).

2.4.2. Level of EBP self-efficacy

Study participants were asked to rate their self-efficacy regarding EBP using the SE-EBP scale, Korean version (Oh et al., 2016). This 26-item instrument is composed of items on EBP core steps, such as "understanding the point of the clinical question" and "searching evidence." The items were rated on a 10-point Likert scale (1 = not confident at all, 10 = very confident). Possible scores ranged from 26 to 260, and participants with higher scores were considered to have a higher level of self-efficacy regarding EBP. The Cronbach's alpha at the time of scale development was .97 (Oh et al., 2016).

2.4.3. Level of evidence utilization

The level of evidence utilization was assessed with questions from the Knowledge, Attitude, and Behavior (KAB) Questionnaire for EBP (Johnston et al., 2003), which was developed to evaluate medical students' levels of personal evidence utilization for EBP. This 10-item (six items to assess resource utilization and four items to assess database utilization) instrument is composed of items such as "How often do you use the following human/material resources in order to seek or look for up-to-date evidence or information?" and "How often do you access the Cochrane Library, a web-based database, to search for evidence?" The items were rated on a four-point scale (1 = not at all, 2 = once every several months, 3 = more than once per month, 4 = more than once per week). Possible scores ranged from 10 to 40; higher scores were indicative of a higher level of evidence utilization. Cronbach's alpha at the time of scale development ranged from .71 to .75 (Johnston et al., 2003).

2.5. Study procedures

This non-randomized experimental preliminary study was conducted in a university college of nursing in Seoul, Korea. Study was conducted from June 18 to September 28, 2015. A convenience sampling was performed, and a total of 48 senior nursing students (sampled from a pool of 82 senior students enrolled in a university college of nursing) who met the inclusion and exclusion criteria and consented to participate in the study. Study participants had opportunity to select one of two groups that they preferred; 22 students chose the intervention group and 26 chose the control group. However, there were three dropouts during the study, thereby resulting in a final sample size of 45 students.

The intervention was intensively delivered for a total of 30 hours over five days during the summer vacation period. In the EBP program, six modules were delivered as lectures. A group project with PBL was done with clinical scenarios. CBL was conducted to teach searching strategies of evidence on online databases. TBL was used in teaching "nursing study design." Two EBP professionals (a school librarian and a clinical expert) were invited as special lecturers on searching databases and the application of EBP in hospitals. All other contents were delivered by the first author of this study.

The study participants in both the control group and the intervention group completed the same self-administered questionnaires twice: at baseline (t_0) and two months after the intervention (t_1). To ensure confidentiality in pairing data, a numbered card was given to each participant; they were requested to specify their card numbers on their respective questionnaires before submitting them to the survey collection box. All study participants had planned to pursue a course on "nursing research," as part of their regular curriculum, two months after the administration of the intervention. To minimize external biases in evaluating the effectiveness of the EBP education, post-test was conducted shortly before the commencement of the new semester (i.e., two months after the intervention).

2.6. Data analysis

Collected data were coded and analyzed using the SPSS/WIN 23.0 software program. Descriptive statistics were used to examine the background characteristics and outcome variables of the participants. Chi-squared tests, Fisher's exact tests, independent-samples t-tests, and Mann-Whitney U tests were conducted to examine group differences

(control versus intervention group) in participant s' characteristics and outcome variables. The Shapiro-Wilk test was used to verify the normality of the study variables. The two variables, EBP knowledge and resource utilization, were not normally distributed; therefore, these variables were analyzed using the Mann-Whitney *U* test. The reliability of the instruments used in the study was analyzed using Cronbach's α and all the analyses were tested against a significance level of .05.

2.7. Ethical consideration

This study was reviewed and approved by the Institutional Review Board of the university (IRB No. 2013–0055). Those students who voluntarily submitted written informed consent form were only considered as the study participants. The ethical principles were upheld throughout the study. Additionally, participants' confidentiality was ensured by coding questionnaires and separating them from the actual data. Each participant in both the intervention and control groups received a coffee coupon worth Korean Won (KRW) 5,000 (approximately United States Dollar (USD) 5) as compensation. Additionally, the intervention group participants received a transportation fee (approximately USD 5 per day), lunch, and snacks; this was necessary because the education program was implemented during the summer vacation. The control group participants received the EBP educational material and attended an EBP lecture after the completion of the research study.

3. Results/findings

3.1. Characteristics of study participants

The mean age of the students was 23.62 (SD = 0.98) years. Forty-two (93.3%) students were women. Thirty-nine (86.7%) students had never taken any course or seminar related to EBP. All the study participants had completed courses on nursing statistics, nursing ethics, and clinical nursing practicum during their junior year; however, none of them had undertaken a course on nursing research. The students' average GPA was 3.40 (SD = 0.41) out of a maximum possible score of 4.30. The level of satisfaction on the nursing profession (7.76 ± 1.43 out of a maximum possible score of 10) and perceived academic achievement (6.87 ± 1.59 out of a maximum possible score of 10) was moderately high. Further, the level of perceived importance of nursing research (8.76 ± 1.15 out of a maximum possible score of 10) and the level of interest in nursing research (7.00 ± 1.87 out of a maximum possible score of 10) were also moderately high. There were no statistically significant differences in demographic characteristics, research-related characteristics, and outcome variables between the intervention and control groups at baseline ($p > .05$; Tables 2 and 3).

3.2. Effects of the EBP education program

3.2.1. Effects on level of EBP knowledge

The average EBP knowledge score of the intervention group increased from t_0 (M = 4.61, SD = 1.19) to t_1 (M = 8.44, SD = 1.24). On the other hand, the average EBP knowledge score of the control group decreased from t_0 (M = 4.35, SD = 1.76) to t_1 (M = 3.95, SD = 1.84). In addition, the results of the Mann-Whitney *U* test revealed that the difference in EBP knowledge between pretest and posttest was significantly higher for the intervention group than the control group (Z = -5.28, $p < .001$; Table 4).

3.2.2. Effects on level of EBP self-efficacy

The average EBP self-efficacy score of the intervention group increased from t_0 (M = 165.05, SD = 45.31) to t_1 (M = 221.76, SD = 25.56). Conversely, the average EBP self-efficacy score of the control group decreased from t_0 (M = 170.96, SD = 35.71) to t_1 (M = 165.96, SD = 31.96). The difference in EBP self-efficacy between pretest and posttest was significantly higher for the intervention group than the control group (t = −6.42, $p < .001$; Table 4).

3.2.3. Effects on level of evidence utilization

The average resource utilization and database utilization scores of the intervention group increased from t_0 (resource utilization: M = 15.10, SD = 2.26; database utilization: M = 10.90, SD = 1.90) to t_1 (resource utilization: M = 17.10, SD = 1.76; database utilization: M = 12.38, SD = 1.47). The average resource utilization score of the control group increased from t_0 (M = 15.17, SD = 2.22) to t_1 (M = 15.38, SD = 2.12). Meanwhile, the average database utilization score of the control group decreased from t_0 (M = 10.71, SD = 1.94) to t_0 (M = 10.50, SD = 1.64; Table 4).

The difference in resource utilization scores between pretest and posttest was significantly higher for the intervention group than the control group (Z = −2.60, $p = .009$). In addition, the difference in database utilization score between the pretest and posttest was also significantly higher for the intervention group than the control group (t = −2.98, $p = .006$; Table 4).

4. Discussion

This study strongly supported that undergraduate senior nursing students who completed an EBP program with blended learning methods had significant improvements in EBP self-efficacy, knowledge, and evidence utilization compared with the control group at a two-month follow-up. While there is no regular EBP course in undergraduate nursing curriculum in South Korea, this study was the first empirical study to develop, implement, and examine the effects of EBP education using blended learning methods in Korean nursing undergraduate students.

The findings of this study concur with the following: the results of a systematic review, which recommended the design and use of pedagogical strategies in undergraduate EBP education (Aglen, 2016); findings that blended learning approaches to teaching and learning EBP are necessary for undergraduate nursing students (Johnson et al., 2010); the conclusions of a thematic literature review, which recommended the use of various interactive and clinical integrated teaching strategies to enhance the EBP knowledge and research utilization skills of nursing students (Horntvedt et al., 2018); and the results of a randomized controlled trial conducted with medical students, which suggest that the blended learning approach is significantly more effective than didactic learning approaches to teaching EBP (Ilic et al., 2015).

Although there are limited studies in nursing discipline, few studies have proved significant improvements in EBP competencies when adopting variety teaching methods in undergraduate EBP education (Ruzafa-Martinez et al., 2016, Andre et al., 2016). In the qualitative study of Andre et al. (2016), which was conducted in Norway, undergraduate nursing students who participated in clinical research projects or education program related to EBP experienced higher motivation and participation, a positive attitude toward EBP, and more focus on critical thinking; however, they reported lower level of knowledge related to EBP. Another quasi-experimental study (Ruzafa-Martinez et al., 2016), conducted in Spain, provided an EBP course for a semester with few seminars and evaluated the EBP course with a competency questionnaire. Ruzafa-Martinez et al. (2016) found that EBP knowledge, self-efficacy, and skills were significantly improved in the intervention group than the control group at two months following the intervention, which is also supported by our study findings.

The blended learning approach comprises both traditional face-to-face and e-learning methods, which helps nursing students learn to integrate theory, research, and practice. In traditional teacher-centered education, nursing students were expected to tackle ill-structured clinical problems before they have acquired the ability to integrate theory and practice (Nickerson and Thurkettle, 2013). This learning environment limits nursing students' clinical performance and nursing

Table 2
Homogeneity test of general and research-related characteristics between the control and intervention groups (N = 45).

Characteristics	Variables	Categories	N (%) or M ± SD			X^2	t or Z	p
			Total (n = 45)	Control Group (n = 24)	Intervention Group (n = 21)			
General	Age (years)[a]		23.62 ± 0.98	23.70 ± 1.04	23.52 ± 0.93		−0.656	.531
	Gender[b]	Men	3 (6.7)	3(12.5)	0(0.0)	2.813		.236
		Woman	42(93.3)	21(87.5)	21(100.0)			
Research-related	Courses taken							
	- Evidence-based practice[b]	Yes	6 (13.3)	2 (8.3)	4 (19.0)	1.113		.396
		No	39 (86.7)	22 (91.7)	17 (81.0)			
	- Nursing research[c]	Yes	0 (0)	0 (0)	0 (0)			
		No	45 (100.0)	24 (100.0)	21 (100.0)			
	- Nursing statistics[d]	Yes	45 (100.0)	24 (100.0)	21 (100.0)			
		No	0 (0)	0 (0)	0 (0)			
	- Nursing ethics[d]	Yes	45 (100.0)	24 (100.0)	21 (100.0)			
		No	0 (0)	0 (0)	0 (0)			
	- Clinical nursing practicum[d]	Yes	45 (100.0)	24 (100.0)	21 (100.0)			
		No	0 (0)	0 (0)	0 (0)			
	Conference attendance	Yes	12 (26.7)	5 (20.8)	7 (33.3)		0.895	.344
		No	33 (73.3)	19 (79.2)	14 (66.7)			
	Grade Point Average (GPA) (0.0-4.3)		3.40 ± 0.41	3.40 ± 0.46	3.41 ± 0.35		0.080	.937
	Satisfaction in nursing profession (0-10)		7.76 ± 1.43	7.76 ± 1.45	7.75 ± 1.45		0.027	.978
	Perceived level of academic achievement (0-10)		6.87 ± 1.59	6.48 ± 1.50	7.21 ± 1.62		−1.567	.125
	Perceived importance of nursing research (0-10)[a]		8.76 ± 1.15	8.71 ± 1.10	8.79 ± 1.22		−0.343	.738
	Interests in nursing research (0-10)[a]		7.00 ± 1.87	7.14 ± 1.93	6.88 ± 1.85		−0.589	.563

NOTE.
[a] Mann-Whitney U test.
[b] Fisher's Exact test.
[c] Core courses for senior year.
[d] Core courses for junior year.

competence (Andre and Barnes, 2010).However, the blended learning approach makes EBP education modules meaningful by linking theories with practice and making the modules more accessible to students with varied learning methods (Johnson et al., 2010).

The EBP education program of this study included TBL, CBL, PBL, lectures, and a group project as educational strategies. In PBL, each group formulated appropriate clinical questions, and 100% succeeded in formulating PICOs. In the heart failure case scenario, for example, students formulated PICO as “Does a tele-monitoring discharge program (I) effective for decreasing the 30-day readmission (O) of heart failure patients (P) compared with usual care (C)?” Findings from this study support the results of an experimental study that was conducted with medical students, whereby students receiving EBP education with PBL demonstrated significantly higher EBP performance and satisfaction (Hosny and Ghaly, 2014). PBL is a pedagogical strategy that promotes inquiry and critical thinking skills; this allows students to find their own answers to clinical questions, rather than merely learn answers to questions (Fineout-Overholt et al., 2008).

In our study, we invited two EBP professionals (i.e., a school librarian and a clinical expert) who delivered special lectures on topics related to searching for empirical evidence and translating evidence into practice. The school librarian used CBL to teach students evidence-searching strategies, which included accessing and retrieving articles from databases such as PubMed, CINHAL, and EMBASE. In this class, students participated in group activities to find the best evidence that is most appropriate to their PICOs. On the other hand, the clinical expert, who was a nurse-manager and an EBP expert at her respective hospital, provided full progress of the EBP project about hand hygiene; this was a live example that demonstrated the translation of evidence into practice. As Horntvedt et al. (2018) have emphasized, these activities help students learn about information literacy, interdisciplinary collaboration, and the retrieval and application of research.

In the developmental stage of study, the contents of EBP program in this study was parallel with EBP related courses, including nursing research, nursing informatics, nursing statistics, and clinical nursing practicums. For example, the content of ‘finding evidence: literature searching strategies’ is closely related with nursing informatics course. Students learned how to generate suitable keywords and search terms and retrieve journal articles from electronic databases using Boolean operators. These efforts allow students to integrate knowledge and skills learned from each nursing core courses, and educators can teach students efficiently. On the other hands, the students were provided with a short intensive program on EBP education during summer vacation. Although regular one semester EBP curriculum is necessary for undergraduate nursing students, this simplified intensive EBP education program can be easily applied to ADN (Associate Degree in Nursing) or RN-BSN (Registered Nurse and the Bachelor of Science in Nursing) program, as EBP should be implemented in all nursing programs to

Table 3
Homogeneity test of outcome variables between the control and intervention groups(N = 45).

Variable	M ± SD			t or Z	p
	Total (n = 45)	Control Group (n = 24)	Intervention Group (n = 21)		
Knowledge	4.47 ± 1.51	4.35 ± 1.76	4.61 ± 1.19	−0.557	.580
Self-efficacy	168.20 ± 40.11	170.96 ± 35.71	165.05 ± 45.31	0.489	.627
Resource utilization	15.13 ± 2.21	15.17 ± 2.22	15.10 ± 2.26	0.107	.915
Database utilization	10.80 ± 1.90	10.71 ± 1.94	10.90 ± 1.90	−0.342	.734

Table 4
Differences in outcome variables between the control and intervention groups ($N = 45$).

Variable	Group	M ± SD			t or Z	p
		Pretest (t_0)	Posttest (t_1)	Difference (t_0-t_1)		
Knowledge[a]	Control	4.35 ± 1.76	3.95 ± 1.84	−0.41 ± 1.52	−5.283	< .001
	Intervention	4.61 ± 1.19	8.44 ± 1.24	3.83 ± 1.65		
Self-efficacy	Control	170.96 ± 35.71	165.96 ± 31.69	−5.00 ± 19.09	−6.417	< .001
	Intervention	165.05 ± 45.31	221.76 ± 25.56	56.71 ± 40.30		
Resource Utilization[a]	Control	15.17 ± 2.22	15.38 ± 2.12	0.21 ± 2.60	−2.600	.009
	Intervention	15.10 ± 2.26	17.10 ± 1.76	2.00 ± 2.51		
Database utilization	Control	10.71 ± 1.94	10.50 ± 1.64	−0.21 ± 1.38	−2.975	.006
	Intervention	10.90 ± 1.90	12.38 ± 1.47	1.48 ± 2.25		

NOTE. [a] Mann-Whitney *U* test.

some degree.

4.1. Limitations

In terms of recent educational trends in EBP, the present study is a meaningful attempt to apply blended learning in EBP education for undergraduates. Our study findings support the potential effectiveness of a semester-long EBP course in regular undergraduate nursing curriculum in South Korea. Nevertheless, the study has limitations. First, the program was delivered in a university, which increased the risk of contamination between the intervention and control groups, as well as reduced the generalizability to all nursing undergraduates. Second, the lack of random assignment (i.e., students self-selected their study group) and small sample size might have affected the intervention effects; therefore, the study findings should be carefully interpreted in terms of generalizations. Finally, a two-month follow-up period is comparatively short; future research is recommended to examine changes in the levels of participants' EBP self-efficacy, knowledge, and evidence utilization at the time of graduation.

5. Conclusions

Integrating EBP into nursing courses by utilizing blended learning enhanced EBP competence of nursing students, including the knowledge, self-efficacy, and evidence utilization skills of undergraduate nursing students. Further studies are recommended on the development of various specific learning strategies to promote EBP education and to integrate EBP education into nursing core courses. Moreover, the train-the-trainne programs for nursing educators are necessary to enhance EBP competency of the educators and to provide standardized and effective EBP education to the undergraduate students. These continuous efforts on the advancement of EBP education are necessary to facilitate EBP in nursing practice and to maximize nursing outcomes in the healthcare system.

Conflicts of interest

The authors declare no potential conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nepr.2019.05.010.

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