Original Article

The Effectiveness of Team-based Case-based Learning Approach on the Learning Outcome: A Single Course Level in a University Setting

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ABSTRACT

Background: Case-based learning (CBL) is becoming an important approach for improving interprofessional collaboration education. Previous studies have examined learners' satisfaction with interprofessional education (IPE) in medical institutions. However, there are few studies on the implementation of university-led CBL interventions and their direct effects on learning outcomes. The aim of this study was to evaluate the effectiveness of CBL interventions on changes in the participants' perception and knowledge acquisition ability. **Methods:** The CBL approach consisted of team-based case-based learning, self-directed learning, and post-feedback. It was conducted as a single course for pharmacy students in their 5th year in a university setting. Changes in the participants' perceptions and self-assessments of competence levels were evaluated using survey responses. The effect of the CBL intervention on knowledge acquisition ability was directly evaluated using the exam score. **Results:** The majority agreed or strongly agreed that team-based case-based learning, and self-directed learning helped them to improve their knowledge and skills to a higher level and to increase the self-assessment of competency level. The average score of knowledge acquisition ability (average score of 75.0, p=0.0098) was significantly higher in the CBL intervention group than the lecture-based learning intervention group (average score of 52.0). **Conclusion:** The participants positively perceived that CBL intervention helped them to effectively improve their knowledge and the self-assessment of competency level. It also enhanced knowledge acquisition ability. These data, based on the survey responses, suggest that it is necessary to implement CBL interventions in a university-led single professional education.

KEYWORDS: interprofessional education, case-based learning, self-directed learning, knowledge acquisition

Case-based learning (CBL) is one of interprofessional education (IPE) learning methods that educates students to assess, discuss, and make decisions by providing real-life situations or problems that are faced by health professionals.[1-3] The IPE and collaborative practice are learning methods developed by medical schools and related institutions in North America and Europe, to improve the quality of patient care and health outcomes in the difficult health environment that is faced by the aging population and global health system.[4-6] According to a study on participation in university-led IPE activities at the American College of Pharmacy, 41 (42%) colleges continuously provided IPE activities through various methods with actual clinical experience. Among these, the most used learning method was interprofessional team-based learning (80%), followed by interprofessional service learning (61%), medical professional shadowing learning (54%), and case-based learning in a classroom environment (34%), while the other infrequently used learning methods were classroom learning (22%) or simulation (17%) learning about the roles of other professionals.[3]

In a study conducted in North America and nine European countries, Barr and colleagues reported that the groups that

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were most involved in IPE were nurses (89%), doctors (82%), and pharmacists (12%), showing that the participation rate of the pharmacists was very low.[7] A sample survey on participation in IPE activities conducted in Korean medical institutions showed that although IPE activities have been implemented in the practice experience curriculum by the hospital pharmacists, IPE activities providing actual clinical experience were insufficient.[8] Above study results on the low IPE participation rate of pharmacists and the lack of IPE opportunities for pharmacy students indicate that a new educational strategy is needed to improve interprofessional collaboration practice in a pharmacy school.

Like the WHO report, IPE requires collaborative learning in which two or more professional students learn from each other and work together,[9] but single professional university faces the barriers of very few different health professional staffs and students, making it difficult for students to participate in the common essential curriculum to learn and work together with students from different health professions.[10] Therefore, the curriculum in a single professional pharmacy school should be designed and implemented to help students develop inter-professional collaboration competency.

In terms of a strategic approach for improving inter-professional collaboration competency, IPE learning method can be applied within a single-professional education or multidisciplinary education. For example, in the case of a role-play or case-based scenario study or simulation study for competency-based IPE, if other specialists are introduced and discussed as a topic of discussion, it indicates that teaching collaboration between professionals may be possible, even in multidisciplinary education.[7] Therefore, CBL is learning approach that can incorporate IPE learning activities into most single-professional university-led classroom environments. This is an in-depth active learning method, which is also called problem-based learning (PBL) in medical schools.[5] In particular, PBL is an effective way to reach IPE goals, such as improving interprofessional communication skills.[11] When a physician presents the patient's problem to a small group of students so that they can arrive at a rational diagnosis, CBL is achieved. The case described here is a story containing educational content, and the data provided is an example of a concrete practice that details the circumstances, thoughts, and emotions of the incident, thus, it is strategically easy for students to understand and access and it can be used as an educational tool to improve professional judgment and

decision-making ability.[12-13] However, depending on the situation, the case used may be an actual case or a virtual case, and there may be a fixed answer or multiple answers. The CBL method can be used in the classroom[14] in the form of discussions, lectures, and small group activities,[12] such as problem-based cases, interrupted cases, discussion-based cases, public hearing cases, role-playing cases, team-based cases, trial cases, directed cases, and a quiz-based case study model, though these may vary depending on the study time, number of participating students, and exposure time to the cases.[13-15] Therefore, the advantage of CBL including simulation exercise, PBL, and self-directed learning for competency-based IPE is to provide experiential opportunities for discussion about improving patient care, reducing risks of medical errors, and professional role and responsibility.[9,14,16,17]

Among the adult learning activities explained above, it is important to identify the effectiveness of CBL, which can approach IPE system, on learning outcome in a university-led single professional education, but, an evaluation tool that can directly measure this is not well established,[18-20] regarding the effect of CBL intervention.[7,21-24] Bergland et al. (2006) found that it increased high-order thinking when applied to actual clinical practice,[25] and some previous studies reported that CBL has positive effect on the knowledge acquisition.[26-28] However, Bassir (2014) described that selected outcome variables and effect of PBL on the knowledge acquisition were varied in a few randomized studies,[29] and the systematic review of Thistlethwaite et al. (2012)[30] failed to support that CBL improved knowledge-related achievement when compared to lecture-based learning activities.[29-31] Therefore, the effect of CBL on the improvement of students' knowledge-related achievement is still inconclusive.

To date, no quasi-experimental studies have been conducted that compared the effectiveness of team-based CBL with that of lecture-based learning in a single professional Korean pharmacy education. Therefore, this study aimed to evaluate the effectiveness of a team-based CBL intervention on changes in the participants' perception and knowledge acquisition ability and to provide a valuable educational strategy for a university-led single professional pharmacy education.

Methods

Study design
This study was designed to examine the effects of this

university-led CBL intervention on learning outcomes in an on-line classroom environment due to the COVID-19 pandemic. The effects of the CBL intervention were evaluated by the change in the participants' perceptions, self-assessment of competency level, and knowledge acquisition ability in a single educational course for improvement which was selected by Duksung Women's University Innovation Support Project (Project: No. Innovation 5-9) in 2021. The curriculum consisted of 13 weeks of lectures, six weeks of team-based CBL, six weeks of self-directed learning, six weeks of team-based projects, six weeks of quizzes, and post-feedback. Changes in the participants' perceptions related to CBL activity and self-assessment competency levels were compared using pre- and post-survey response before and immediately after education. The seven survey questionnaire items related to CBL were as follows: 1, to understand the CBL activity more effectively; 2, effectively manage self-directed learning; 3, to effectively improve my knowledge and skills to a higher level; 4, to effectively identify my competency and my limitations; 5, self-assessment of competency level in applying knowledge to patient-centered management, solving problems, and collaborating with health professionals; 6, the kinds of CBL interventions that are suitable for improving learning outcomes; and 7, the most appropriate way of implementing CBL activities. The study design was approved by the Institutional Review Board (IRB: No. 2021-011-015-B) of the Duksung Women's University with a nonhuman designation, and the study was conducted in accordance with the Declaration of Helsinki.

Team-based case-based learning activity intervention and participants

This study was conducted on 5th year students (n=89) in the Pharmacy School who participated in the educational course for improvement from March to June 2021. This educational intervention incorporated team-based CBL and self-directed learning. Before the start of the education, detailed information about the purpose of the education, learning method, grade evaluation method, and learning schedule was provided and explained to the participants using handouts. The participants were asked to voluntarily in the pre- and post-survey questionnaires. At the beginning of the CBL, the facilitator provided the participants with a detailed ward patient case as a handout, divided the participants into small groups, and instructed them to participate in the 20-min discussion by applying their clinical knowledge. The cases used were composed of various dramatic virtual or real scenarios, split into three levels according to difficulty, that could occur in patients. Each scenario required the students to apply their knowledge on drug treatment and patient-centered treatment, as well as their problem-solving, team collaboration, and communication abilities.

After the 20-min team discussion, the participants were instructed to draw the treatment results in small groups in an online lecture and present the results in a chat window. After the presentation, all the participants were provided with post-feedback from their facilitator and participated in the question-and-answer session.

After completing the CBL, the participants participated in self-directed learning and team-based project discussions. Each team then submitted the completed assignment using an electronic learning system. The facilitator checked the tasks that were submitted by the teams, provided feedback to the participants, and helped them to enhance their problem-solving abilities. Six quizzes were administered to the participants who had completed the CBL and self-directed learning. The results were provided to the participants. The participants who completed the educational course immediately responded to the post-survey questionnaire and participated in a written case study exam for assessing knowledge acquisition ability.

Data analysis

The data were assessed using descriptive statistics. The CBL activities were created by referring to IPE activities such as team-based CBL and self-directed learning.[4]

Data on the changes in the participants' perceptions of each item were expressed as a number and percentage and ranged from strongly agree to strongly disagree as a Likert-type response. Responses to changes in the participants' perceptions of the self-assessment of competency levels were compared quantitatively and expressed as percentages. The effectiveness of the CBL intervention on knowledge acquisition ability was expressed by the average score of the learning outcome, and the outcome of the participants who participated in CBL in 2021 was compared to that of the participants who participated in lecture-based learning in 2020. Since the small group of study participants was led by one facilitator, it was estimated that there would be no significant difference in the educational experience, learning method, intensity, and knowledge level due to the educator. The statistical significance was set at $p \leq 0.05$.

Results

Response to the survey and written exam

All 89 (100%) students agreed to proceed with CBL and participated in the CBL course and learning outcome examination. The data were collected from 37 (41.6%) participants who responded to the pre-survey questionnaire, 35 (39.3%) who responded to the post-survey questionnaires, and 89 (100%) who participated a written case study exam, as presented in Table 1.

Changes in the participants' perception of the case-based learning approach

As explained in Table 1, more participants either strongly agreed or agreed in the post-survey questionnaire that CBL intervention helped them to effectively manage self-directed learning, effectively identify their competency and limitations, and effectively improve their knowledge and skills to a higher level when compared to the results of the pre-survey. No participants strongly disagreed with the items except for item 1 (2.9%), which was "effectively identified my competency and my limitations" in the post-survey. The highest agreement rating for the participants who responded to the post-survey was for the item "effectively improved my knowledge and skill to a higher level".

Suitable case-based learning interventions to improve learning outcomes

The most preferred CBL intervention by participants was "Lecture-based learning to help learners better understand" in the pre-survey. Although, this item showed the highest decline in the participants' perception from 25 (67.6%) to 15 (42.9%) in the post survey (Table 2), it was the most preferred CBL intervention by the participants along with "Self-directed learning activity".

The least desired CBL intervention by participants was "team-based case-based learning", which showed similar preference in both the pre- (n=4,10.8%) and the post-surveys (n=3, 8.6%) as in Table 2. The most appropriate way to implement CBL activity was "Providing time and space to review daily educational contents" in both the pre- (n=21, 56.8%) and post-surveys (n=21, 60.0%) in Table 2.

Self-assessment of competency level

In terms of the item, "self-assessment of competency level", 14 (37.9%) participants rated their competency level as 60 or higher initially, and after four months, the self-rating of their competency level at 60 or higher was greatly increased to 23 (65.8%) in Fig. 1.

Knowledge acquisition ability

As explained in Fig. 2, the knowledge acquisition ability (average score 75.0) of the learners who participated in CBL and self-directed learning was significantly higher than that (average score of 52.0) of the learners who participated in lecture-based learning (p value=0.0098).

Table 1. Changes in participants' perceptions on CBL intervention in a single course level

Survey questionnaires	Pre survey (n, %)[a] number of participants=37					Post survey (n, %)[a] number of participants=35				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
How will/did CBL[b] intervention[c] help you										
To understand CBL activity more effectively	2(5.4)	12(32.4)	20(54.1)	3(8.1)		3(8.6)	23(65.8)	8(22.8)	1(2.9)	
To effectively manage self-directed learning	1(2.7)	15(40.5)	19(51.4)	2(5.4)	0	1(2.9)	21(60.0)	12(34.3)	1(2.9)	0
To effectively improve my knowledge and skill to a higher level[b]	-	-	-	-	-	3(8.6))	25(71.4)	6(17.1)	1(2.9)	0
To effectively identify my competency and limitations	3(8.1)	19(51.4)	13(35.1)	2(5.4)	0	0	22(62.8)	11(31.4)	1(2.9)	1(2.9)

[a]Data are expressed by number and percentage.
[b]CBL, Case-based learning
[c]CBL learning intervention includes team-based case-based learning, and self-directed learning.

Table 2. Participants' perceptions on the CBL approach suitable for improving learning outcomes

Survey questionnaires	Pre survey (n, %)[a] number of participants=37	Post survey (n, %)[a] number of participants=35
	(Multiple answer choice)	
What kinds of CBL[b] interventions[c] are suitable for improving learning outcome		
Clinical practice experience and communication skill	11 (29.7)	10(28.5)
Self-directed learning activity	15(40.5)	15(42.9)
Team-based case-based learning	4(10.8)	3(8.6)
Competency-based learning & post feed-back	10(27.2)	12(34.3)
Lecture-based learning to help learners better understand	25(67.6)	15(42.9)
What is the most appropriate way to implement CBL learning activity		
Developing a student-centered learning activity	2(5.4)	4(11.4)
Using Team-based discussion & self-directed learning activity	1(2.7)	5(14.3)
Providing a team room for small group-based discussion	0	0
Providing time and space to review daily educational contents	21(56.8)	21(60.0)
Facilitating the learning to help learners to think critically	13(35.1)	5(14.3)

[a]Data are expressed by number and percentage.
[b]CBL, Case-based learning
[c]CBL learning intervention includes team-based case-based learning, and self-directed learning.
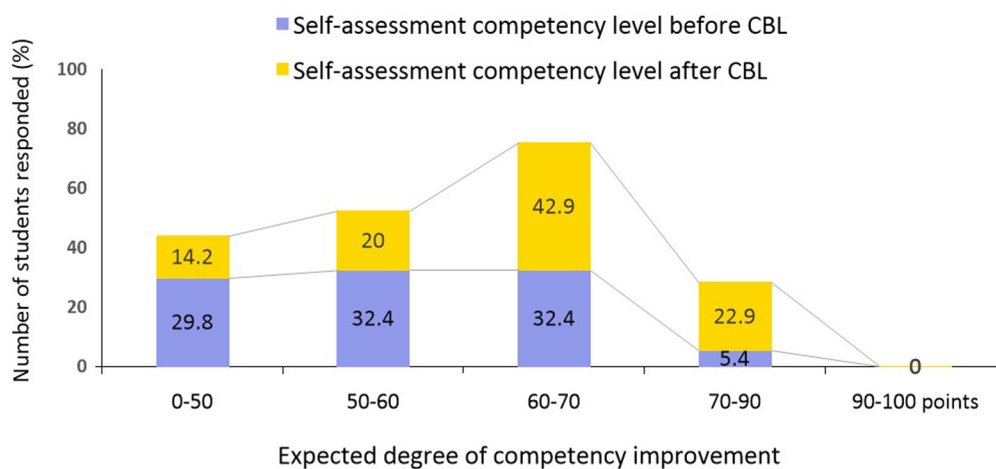

Fig. 1. Comparison of learners' perception related to self-assessment of competency level before and after team-based CBL intervention. There was strong agreement or agreement that the CBL intervention was effective in improving the self-assessment of competency level four months after the beginning of the education. CBL, Case-based learning

Discussion

This study examined the effectiveness of CBL interventions using team-based CBL activity, and self-directed learning methods to improve learning outcomes in a single course in pharmacy education. The data collected from the CBL curriculum highlighted that more than 60% of the participants either strongly agreed or agreed that CBL intervention was effective methods in improving learning outcome. Accordingly, team-based CBL and self-directed learning methods had a positive impact on the change in the participants' perceptions of the team-based CBL intervention.[10]

There was strong agreement or agreement that the team-based CBL intervention was effective in improving the self-assessment of competency level and their knowledge acquisition ability to a higher level four months after the
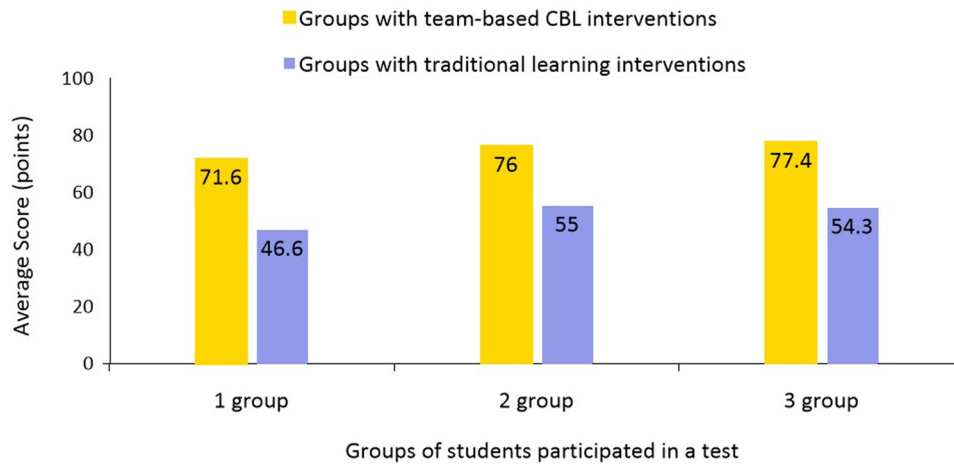
Fig. 2. Comparison of knowledge acquisition ability of the learners who participated in team-based CBL intervention to that of the participants who participated in lecture-based learning. The knowledge acquisition ability (average score 75.0) of the learners who participated in team-based CBL and self-directed learning was significantly higher than that of the participants who participated in lecture-based learning (*p* value=0.0098). CBL, Case-based learning

beginning of the education. This result suggests that participants recognize that their learning outcomes could be improved with the team-based CBL activity. The above results were obtained through the pre- and post-survey responses because the pre- and post-survey consisted of the same questionnaire items, so the collected data were paired, except for one item which was added in the post-survey, "to effectively improve my knowledge and skill to a higher level". However, as both the team-based CBL course and survey were conducted as an on-line, the response rate was poor. Consequently, the study was limited to estimating the change in the participants' perceptions based on these findings.

Nevertheless, the results of this study suggest that a single-professional university-led team-based CBL curriculum is an effective strategy for improving knowledge acquisition ability and identifying learners' competency levels after a single course.[32] Therefore, it is crucial to build an IPE system at the single professional pharmacy education and allow students to learn a new educational approach. However, further research is required to determine whether single-professional university-led team-based CBL intervention at the whole-curriculum level is effective in improving learning outcomes.

There are various learning methods to approach IPE, among which interactive learning includes discussion, debates, problem-based, CBL and small group work.[33] The IPE approach which was used in this study was created by referring to a guide to IPE activities from the University of British Columbia[21] and the building block and sequential IPE

learning approaches which was developed by the Western University of Health Sciences[21,34-35] in the USA. Therefore, the team-based CBL intervention is similar to their educational approach but the level of education, the classroom equipped with the team-based CBL system, and the number of facilitators who participated were different from the educational environment which was provided by these universities.

Before the start of the lecture, it was found that more than half of the students (n=25, 67.6%) who had never experienced team-based CBL preferred passive lecture-based education as a suitable learning method, but after completing four months of education, the students' preference for this item (n=15, 42.9%) showed a declining change. In terms of an appropriate way to approach the CBL, the participants' preference for using team-based discussion had changed positively after completing four months of education, but no one selected the item like "providing a team room for small group-based discussions" as the most appropriate way to improve learning outcome.

Initially, participants did not prefer team-based discussions or team-based CBL together in a small group, preferring participating in a self-directed learning activity without socially cooperating with their peers instead at the beginning of team-based CBL. Moreover, only a small number of participants selected "developing a student-centered learning activity" as the most appropriate team-based CBL method. However, after four months of team-based CBL, study results showed that the participants' perception of "using team-based

discussion and self-directed learning activity" had changed positively, and they showed the greatest interest in "providing time and space to review daily educational content" in both pre- and post-survey.

Therefore, it is suggested that team-based CBL is an effective learning method for students who need to improve their learning outcomes with their peers and for academic institutions to develop and implement IPE systems. As participants recognized that post-feedback interventions may improve learning outcomes during team-based discussions, CBL, and team projects, the application of post-feedback intervention to interprofessional learning is recommended.

Finally, the knowledge acquisition ability of the learners who participated in team-based CBL compared to that of the learners who participated in lecture-based learning was significantly higher and the average scores of the three classes that attended CBL education were similarly maintained above 70 points.[23,29,30] The both pre- and post-survey response rate were low, but both survey response rate remained similar level, making it possible to estimate changes in the participants' perceptions. However, participation in on-line classes and using a survey format through the e-learning system may be the reasons for the poor response rate. Access to the survey questionnaire may have been restricted if the participants did not frequently access the e-learning system or if they did not upload their responses. The poor response rate in this study may affect the reliability of the results; therefore, it would be better to consider other methods to improve data collection in future studies.

Unlike previous studies[7,23] that only evaluated participants' perception and attitude changes, this study directly compared knowledge acquisition ability with the control group and showed that the results were in favor of team-based CBL intervention, but the heterogeneity across the control group and case study written exam could be responsible for the inconsistent results. Confounding variables such as differences in baseline, team-based CBL learning methods, assessment tool, and differences in outcome types before and after team-based CBL intervention in the same school may affect the study results,[10] it is important to interpret the effect of team-based CBL approach in consideration of such variables' difference.[26,36] The barriers to implementing team-based CBL include a lack of time to help students with better understanding, lack of space for team-based discussion, and lack of facilitators to supervise them and provide feedback during

class hours. All the findings of this study were collected from survey responses after a single course. Therefore, the study results might not be able to be extrapolated to the effect of team-based CBL intervention at the whole-curriculum level.

Conclusion

Overall, this study identified that team-based CBL and self-directed learning methods had a positive impact on the change in the participants' perception of improving their knowledge and skills and the self-assessment of their competency level. In addition, this study showed a significant improvement in knowledge acquisition ability after a single course during pharmacy education four months after the beginning of CBL. According to the positive evidence from the survey responses, it may be appropriate to apply CBL interventions to single professional university-led pharmacy education.

It is necessary to support educational strategies such as team-based case based learning and self-directed learning methods to facilitate student learning. Further research is required on the implementation of CBL at the university-led whole curriculum level.

Acknowledgment

Conflicts of Interest

The authors have no conflicts of interest to declare with regards to the contents of this study.

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