A systematic review of selected evidence on developing nursing students’ critical thinking through problem-based learning

Haobin Yuan a,*, Beverly A. Williams b, Lin Fan c

a School of Nursing, Fudan University, Shanghai, PR China
b Faculty of Nursing, University of Alberta, Edmonton, Canada
c Shengjing Hospital (The second affiliated hospital of China Medical University), Shenyang, PR China

Accepted 20 December 2007

Summary
Rapidly changing developments and expanding roles in healthcare environment requires professional nurses to develop critical thinking. Nursing education strives to facilitate students’ critical thinking through the appropriate instructional approaches. Problem-based learning (PBL) is a student-centered approach to learning which enables the students to work cooperatively in small groups for seeking solutions to situations/problems. The systematic review was conducted to provide the available evidence on developing nursing students’ critical thinking through PBL. The computerized searches from 1990–2006 in CINAHL, Proquest, Cochrane library, Pubmed etc were performed. All studies which addressed the differences in critical thinking among nursing students in PBL were considered. Two independent reviewers assessed the eligibility of each study, its level of evidence and the methodological quality. As a result, only ten studies were retrieved, they were: one RCT with a Jadad quality score of 3, one nonrandomized control study, two quasi-experimental studies with non-controlled pretest-posttest design, and six descriptive studies. The available evidence in this review did not provide supportive evidence on developing nursing students’ critical thinking through PBL. Clearly, there is a need for additional research with larger sample size and high quality to clarify the effects of PBL on critical thinking development within nursing educational context.

Introduction
In a contemporary healthcare environment characterized by rapidly-changing developments and...
Relentlessly-increasing knowledge, professional nurses need to develop critical thinking skills that will provide them with expertise in flexible, individualized, situation-specific problem solving (Higgs and Jones, 2000). Therefore, nursing education strives to facilitate the development of students' critical thinking through the appropriate instructional approaches (Bowles, 2000). Problem-based learning (PBL) is a student-centered approach to learning which enables the students to work cooperatively in small groups for seeking solutions to situations/problems (Rideout and Carpio, 2001). Students encounter the problem-solving situations in small groups. The groups have to decide what information they need to identify the situation/problem as issue, try to understand it, communicate it to the others in the group, and then re-formulate it in such a way that they can deal with the problem. Students' critical thinking is fostered through their group discussions (Wood, 2004). There was a theoretical basis for using PBL to promote students' critical thinking, but the findings of pervious studies were mixed. It should be concerned whether PBL actually demonstrated more effect on developing nursing students' critical thinking compared with other instructional methods? The systematic review related to that question was necessary to be conducted.

Objectives

The objective of this review was to systematically assess the literature and present the best available evidence for developing nursing students' critical thinking through PBL. The addressed research questions were:

1. What is the effect of PBL on nursing students' critical thinking?
2. Does the available evidence provide information for developing nursing students' critical thinking through PBL?

Criteria for considering studies for this review

Type of participants

The study populations considered in this review were the subjects who were participating in nursing educational programs.

Type of intervention

PBL was considered as the intervention in this review. PBL was defined as learning which results from the process of working towards understanding or resolution of a situation/problem. Situations/problems became the context for students to learn problem-solving skills and acquire knowledge. Students tackled situations/problems in small groups under the supervision of a tutor. The essential characteristics of PBL were situation/problem as a stimulus for learning, the student-centered approach, small group work and tutors as facilitators (Rideout and Carpio, 2001).

Types of studies

In order to search all the available evidence, randomized controlled trials, nonrandomized controlled trials, uncontrolled quasi-experimental studies, qualitative studies and descriptive studies were considered in this review. Studies with non-PBL approach were excluded.

Search strategy

All major electronic sources of relevant information were systematically searched to identify peer-reviewed English and Chinese language abstracts or papers published between 1990 and 2006. The search sought both the published studies and submitted doctoral dissertations. To identify all relevant studies for the review, the search strategy comprised searches of the following: CI-NAHL database, Proquest, Cochrane library, PubMed, Medline, Science Direct, OVID and Chinese Journal Full-text Database, Internet source (www.google.com) using the key words: “problem-based learning, critical thinking, nursing, and effect”.

Assessment of methodological quality

Two independent reviewers assessed the eligibility of each study, its level of evidence and the methodological quality. The level of evidence of each retrieved study was assessed according to Sackett et al. (2000) (See Appendix 1). Assessment of quality was limited to experimental studies. The quality of controlled trials was evaluated with the Jadad scale (See Appendix 2) focusing on the methods for random allocation, double-blinding, and withdrawals and drop-outs. The total scores ranged from 0 to 5 points, where trials with 0–2 points were considered to be of poor quality, and those with 3–5 points represented high quality trials. The interrater coefficient of agreement (kappa-κ) was reposted as 0.66 for the whole scale (Jadad et al., 1996).
Types of outcome measures

The outcome measures in this review included students’ perceptions of the change in critical thinking, the California Critical Thinking Dispositions Inventory (CCTDI), The California Critical Thinking Skills Test (CCTST) and The Watson–Glaser Critical Thinking Appraisal (WGCTA). The CCTST was a 6-point Likert scale, consisted of 75 declarative statements with 9–12 items attributed to each of the subscales. Standardized scores were calculated for each subscale (subscale raw scores were multiplied by 10 and divided by the number of items on the subscale). Individuals’ responses generated an overall score and seven subscale scores: truth-seeking, open-mindedness, analyticity, systematicity, confidence, inquisitiveness and maturity. The scores ranged from 5 to 60 for each subscale, giving a maximum inventory score of 420 (range of 35 to 420). Scores above 350 reflected a strong disposition, scores between 280 and 350 indicated a positive inclination, and scores under 280 reflected an overall deficiency in critical thinking disposition. The overall Cronbach alpha internal consistency reliability coefficients were 0.91. The grounding in the American Philosophical Association (APA) Delphi study supported the validity (Facione, 1997).

The CCTST was a standardized, 34-item multiple-choice test which targeted the critical thinking skills including analysis, evaluation, inference, deductive reasoning, and inductive reasoning. Each correct response was assigned one point; therefore, scores ranged from 0 to 34, with higher scores reflecting stronger critical thinking skills. Internal consistency of CCTST-A was reported as Kuder Richardson-20 (KR20). KR20 ranged from 0.68 to 0.70. Construct validity of the CCTST-A was supported by the APA Delphi study (Facione, 1994).

The WGCTA was a standardized, assessment tool for measuring the foundation critical thinking skills including inference, recognition of assumptions, deduction, interpretations and evaluation of arguments. It was available in parallel Forms A and B, and an abbreviated Version (Form S). WGCTA Form A and B consisted of 80 items, scores ranged from 1 to 80. The split-half reliability coefficients ranged from 0.69 to 0.85. The short version of WGCTA consisted of 16 scenarios and 40 items. Cronbach’s alpha reliability coefficient was .81 (Watson and Glaser, 1994).

Findings

Initially 273 English articles and 23 Chinese articles were found. However, several were discarded as they did not specifically address critical thinking as an outcome of PBL. Only ten studies conducted to measure differences in critical thinking among nursing students in PBL were retrieved in this review. These studies included one RCT with a Jadad quality score of 3, one nonrandomized control study, two quasi-experimental studies with non-controlled pretest-posttest design, and six descriptive studies. The findings of this review were presented as narrative summaries. The description of the reviewed studies was shown in Table 1.

Joe and Elizabeth (1999) described the outcomes of PBL as a teaching method for 24 nursing students. PBL encouraged students to take large amounts of information and synthesize that information for presentation back to their group and think critically. Celia and Gordon (2001) assessed 26 novice nurses from an 18-week PBL program. The best features of PBL were considered as group participation, self-directed learning, interacting with various individuals, and recognizing how to apply critical thinking skills. The nursing students indicated that PBL promoted critical thinking and problem solving, and active participation in the learning process. The clear PBL benefits for the nursing students included increased autonomous learning, critical thinking, problem solving, and communication skills (Cook and Moyle, 2002; Morales-Mann and Kaitell, 2001). In Mainland China, PBL were applied to clinical nursing education and classroom teaching. Student indicated that PBL helped them to understand and memorize the knowledge and enhanced their abilities of self-directed learning, critical thinking, cooperative group working (Wang et al., 2004; Yuan and Qian, 2003).

Day and Williams (2002) adopted a PBL curriculum in one baccalaureate-nursing program among 27 years 1 student in Canada. Quasi-experimental one-group pretest and posttest design was conducted. The CCTST and CCTDI were used to measure critical thinking. The students’ critical thinking increased significantly in mean overall scores of 1.89 on CCTST ($t = 2.650, p = .014$) and 17.24 on CCTDI ($t = 1.915, p = .070$). Students’ critical thinking skills and dispositions did increase over one year of using PBL. Furthermore, one RCT with a Jadad quality score of 3 was conducted to test the effect of PBL on students’ critical thinking development. The CCTDI was used to measure students’ critical thinking. The first year undergraduate nursing students ($n = 79$) at a university in Hong Kong were randomly assigned to 1 of 2 parallel courses delivered by either PBL ($n = 40$) or lecturing ($n = 39$) over one academic year. Both PBL group and lecture group were enrolled in a two-
<table>
<thead>
<tr>
<th>Study Level of Evidence</th>
<th>Design</th>
<th>Sample</th>
<th>Instruments</th>
<th>Intervention</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joe and Elizabeth (1999) level IV</td>
<td>Descriptive study</td>
<td>24 nursing students</td>
<td>PBL evaluation questionnaire PBL assessment questionnaire</td>
<td>One-year PBL course</td>
<td>Promoting critical thinking was the major outcome of PBL. The best features of PBL were self-directed learning, and recognizing how to apply critical thinking skills. Students satisfactorily demonstrated the learning outcomes of PBL included critical thinking, self-direction and effective communication.</td>
</tr>
<tr>
<td>Celia and Gordon (2001) level IV</td>
<td>Descriptive study</td>
<td>26 novice nurses</td>
<td>18-week PBL program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morales-Mann and Kaitell (2001) level IV</td>
<td>Descriptive study</td>
<td>56 Year 2 nursing students</td>
<td>Open-end questions</td>
<td>One-year PBL course</td>
<td></td>
</tr>
<tr>
<td>Cook and Moyle (2002) level IV</td>
<td>Descriptive study</td>
<td>100 year 2 nursing students</td>
<td>Four-week PBL program</td>
<td>PBL promoted critical thinking, problem solving, and active participation.</td>
<td></td>
</tr>
<tr>
<td>Wang et al. (2004) level IV</td>
<td>Descriptive study</td>
<td>19 year 3 nursing students</td>
<td>Six-week PBL clinical education Four-week PBL program</td>
<td>PBL improved the self-directed learning and critical thinking abilities. PBL enhanced self-directed learning, critical thinking, and cooperative group working. Students' critical thinking skills and dispositions did increase over one year of using PBL.</td>
<td></td>
</tr>
<tr>
<td>Yuan and Qian (2003) level IV</td>
<td>Descriptive study</td>
<td>29 year 2 nursing students</td>
<td>Four-week PBL program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day and Williams (2002) Level Ib</td>
<td>Quasi-experimental study one-group pretest-posttest</td>
<td>27 year 1 nursing students</td>
<td>CCTST CCTDI</td>
<td>One-year PBL program</td>
<td></td>
</tr>
<tr>
<td>Tiwari et al. (2006) Level Ib</td>
<td>Quasi-experimental study one-group pretest-posttest</td>
<td>79 year 1 nursing students</td>
<td>CCTDI</td>
<td>Tow-semester course Experimental group: PBL Control group: lecture Four-year PBL program</td>
<td>Compared with the lecture students, the PBL students showed significantly greater improvement in critical thinking. The findings were mixed. Only students with low critical-thinking score at the pretest experienced a significant increase over the PBL program. PBL did not improve the nursing students' critical thinking.</td>
</tr>
<tr>
<td>Magnusseen et al. (2000) Level Ib</td>
<td>Quasi-experimental study one-group pretest-posttest</td>
<td>228 nursing students at entry and 257 at exit from the program</td>
<td>The WGCTA Form A (at the pretest); Form B (at the posttest)</td>
<td>Four-year PBL program</td>
<td></td>
</tr>
<tr>
<td>Choi (2004) Level Ib</td>
<td>Quasi-experimental study nonrandomized control group pretest-posttest</td>
<td>76 nursing students</td>
<td>CCTST</td>
<td>One-year PBL course learning Experimental group: PBL Control group: lecture</td>
<td></td>
</tr>
</tbody>
</table>

### Table 1 The description of the reviewed studies
semester course. When no difference in critical thinking between two groups at the pretest, the PBL students \((n = 38)\) demonstrated a mean of 276.32 \((SD = 25.8)\) which was a significantly higher overall critical thinking disposition score on completion of the first semester course when compared with the students in lecture group \((n = 36)\) with a mean of 263.11 \((SD = 21.64, p = .02)\), and these scores improved over the time. After two semesters the PBL students \((n = 32)\) had a mean of 281.63 \((SD = 22.19)\) while the lecture group \((n = 27)\) had a mean of 267.67 \((SD = 22.19, p = .022)\). Moreover, the PBL students continued to have higher scores than the lecture students for two years afterwards. In individual interview, the PBL students described how they were inspired by the fellow students to think more critically during the tutorials (Tiwari et al., 2006). However, Magnusseen and colleague’s study (2000) provided the mixed findings. The WGCTA Form A was used as the pretest (in the first week of school), and Form B was used as the posttest (during the final semester of program). Students with low critical-thinking scores in the beginning of the program experienced a significant increase in mean scores of 2.23 by program end \((t = 2.76, p < 0.01)\), while students in middle group demonstrated no change in mean scores, and those in the highest group actually had a significant drop in mean scores of 4.79 \((t = -4.81, p < 0.01)\) at the end of the program. Choi (2004) conducted pretest-posttest with nonequivalent control group research to examine the effects of PBL on the meta-cognition, critical thinking, and problem solving process in a one-semester course learning among 76 nursing students in Korea. Meta-cognition and problem solving process were assessed by questionnaires which were developed using pedagogics. Critical thinking was measured by the CCTST. The findings indicated that PBL improved the students’ meta-cognition and problem solving process but not their critical thinking skills. The relationship between meta-cognition and the problem solving process was supported but the relationship between critical thinking and problem solving was not supported significantly.

Discussion

Problem-based learning was an instructional approach that challenges students to seek solutions to real-world situations/problems in groups. The PBL students perceived that they developed stronger thinking and problem-solving skills, more effective communication skills, and a greater sense of personal responsibility than did students who received lectures, and their perceptions showed that the curriculum encouraged critical thinking significantly increased (Williams, 1999). The problem-solving process in PBL was closely linked to intellectual processes and critical thinking. The intellectual process consisted of identifying and analyzing the problem, assessing the need for further information and knowledge, considering the alternative explanations or solutions, and implementation and evaluation. Critical thinking involved the abilities to identify problems, to reason and to make decisions about what is important and what alternative solutions are possible (Dolmans et al., 2001).

Theoretically, using PBL can promote students’ critical thinking skills, but the findings of systematic review were failed to provide supportive evidence. This might be explained as the following reasons: First, to develop critical thinking, students needed to develop an awareness of the behavioral, environmental and metacognitive influences on higher order thinking skills. These influences needed to be valued by teachers and students and should be addressed during teaching and learning activities and consistent from course to course (Ironside, 1999). It should be noted that PBL as an instructional approach was often used in one course while all other courses were delivered in a traditional manner. The traditional learning environment was possibly modified to foster growth in students’ critical thinking and reasoning skills. This made it difficult to detect improvement due to the experimental intervention if the traditional classroom provided an effective teaching and learning environment. Second, critical thinking had been defined in a variety of ways. There were several standardized tests used to measure critical thinking for education settings and curriculum development. The different validity and reliability of instruments might influence the outcome measure. Finally, the RCT was considered to provide the best evidence of efficacy for an intervention by attempting to minimize biases and confounding variables. Because of the very rigor of an RCT, it might not necessarily be appropriate to generalize the results of such a carefully controlled trial into other educational situations. Subjects for RCTs were selected according to strict and often limited criteria, researchers were highly trained and a standardized intervention was applied to all subjects, regardless of individual subject characteristics and educational presentations (Sackett et al., 2000). Thus an effect of PBL on critical thinking in an RCT might not be effective when it is used
for the student population within different nursing educational context.

In summary, systematic review was conducted to provide a comprehensive summary and synthesis of existing high quality research, but the available evidence in this review did not provide robust evidence about the effect of PBL on nursing students’ critical thinking development.

Conclusions

The key finding of this systematic review was the lack of large high quality RCTs which determined the effects of PBL on critical thinking development. Clearly, PBL research in nursing education was still at its infancy. Whether this approach was appropriate for nursing education or not was still questionable. Additional research with larger sample size and high quality should be conducted to clarify the effects of PBL on critical thinking development within nursing educational context.

Appendix 1

The levels of evidence outline by Sackett et al. (2000) are as follows:

Level I:
Ia Systematic Review of Randomized Controlled Trials (RCTs)
Ib RCTs with Narrow Confidence Interval
Ic All or None Case Series

Level II:
IIa Systematic Review Cohort Studies
IIb Cohort Study/Low Quality RCT
IIc Outcomes Research

Level III:
IIIA Systematic Review of Case-Controlled Studies
IIlb Case-controlled Study

Level IV Case Series, Poor Cohort Case Controlled

Level V Expert Opinion

Appendix 2. Jadad’s Scale (Jadad et al., 1996)

(1) Is the study randomized?
2 points: the method to generate the sequence of randomization is described and is appropriate (eg. table of random numbers, computer generated).
1 point: the method to generate the sequence is not described.
0 point: the method to generate the sequence of randomization is described and is inappropriate.

(2) Is the study double blinded?
2 points: The method of masking is described and appropriate (eg. identical placebo).
1 point: The method of masking is conducted but not described.
0 point: The method of masking is described and inappropriate.

(3) Is there a description of withdrawals?
1 point: The withdrawals are defined, as trial participants who were included in the study but did not complete observation period or who were not included in the analysis (but should have been described). If there were no withdrawals, the report should have said so.
0 point: there is no statement of withdrawals.

References


