

**Efficacy of teaching methods used to develop critical thinking
in nursing and midwifery undergraduate students: A systematic
review of the literature**

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Efficacy of teaching methods used to develop critical thinking in nursing and midwifery undergraduate students: A systematic review of the literature.

Abstract

Background: The value and importance of incorporating strategies that promote critical thinking in nursing and midwifery undergraduate programs is well documented. However, relatively little is known about the effectiveness of teaching strategies in promoting CT. Evaluating effectiveness is important to promote 'best practice' in teaching.

Objective: To evaluate the efficacy of teaching methods used to develop critical thinking skills in nursing and midwifery undergraduate students.

Data sources: The following six databases; CINAHL, Ovid Medline, ERIC, Informit, PsycINFO and Scopus were searched and resulted in the retrieval of 1,315 papers.

Review methods: After screening for inclusion, each paper was evaluated using the Critical Appraisal Skills Programme tool. Twenty-eight studies met the inclusion criteria and quality appraisal.

Results: Twelve different teaching interventions were tested in 8 countries. Results varied, with little consistency across studies using the same type of intervention or outcome tool. Sixteen tools were used to measure the efficacy of teaching in developing critical thinking. Seventeen studies identified a significant increase in critical thinking, while nine studies found no increases, and two found unexplained decreases in CT when using a similar educational intervention.

Conclusions: Whilst this review aimed to identify effective teaching strategies that promote and develop critical thinking, flaws in methodology and outcome measures contributed to inconsistent findings. The continued use of generalised CT tools is unlikely to help identify appropriate teaching methods that will improve CT abilities of midwifery and nursing students and prepare them for practice. The review was limited to empirical studies published in English that used measures of critical thinking with midwifery and nursing students. Discipline specific strategies and tools that measure students' abilities to apply CT in practice are needed.

Key words: critical thinking, nursing, midwifery, teaching methods, evaluation

Highlights

- Evidence-based teaching methods are needed to develop critical thinking skills.
- Evaluation of teaching methods and effect on critical thinking is inconsistent.
- Problem-based learning methods are commonly used to develop critical thinking.

- Standardised, discipline specific tools are required to measure critical thinking in practice.
- Active constructivist-based learning strategies are vital in educating nurses.

Introduction

Critical thinking (CT) involves making judicious purposeful judgements as a result of engaging in a process of analysis, interpretation evaluation, inference, explanation, and reflection (Facione, 1990). According to Castledine (2010), critical thinking requires clinicians to carefully define and analyse problems, with a sense of inquisitiveness and questioning of information and decisions. This sense of inquiry is crucial for nurses and midwives working in complex and demanding environments with increased accountability, autonomy and collaboration with other disciplines (Muoni, 2012; Pucer et al., 2014; Castledine, 2010). Therefore, an important aim of nursing and midwifery undergraduate education is to develop students' critical thinking abilities in preparation for practice.

Although there is agreement about the value and importance of incorporating strategies that promote critical thinking in nursing and midwifery undergraduate programs there is little understanding regarding the best approaches to develop these skills (Tiwari, et al, 2006). The inadequacy of the traditional lecture format to promote critical thinking is well documented (Banfield, et al 2012; Popil, 2011). However, relatively little is known about the effectiveness of active learning strategies in promoting critical thinking.

A qualitative systematic review of critical thinking development in nursing explored participant's perspectives, as well as facilitators and barriers (Chan, 2013). Analysis of the 17 studies illustrated that the definition and concept of critical thinking changed from time to time, and identified the need to clarify educators' perspectives towards critical thinking. This review did not include any quantitative studies and tools used to measure the impact of teaching strategies on critical thinking development were not reported. Accordingly, Chan (2013) recommended an evaluation of teaching strategies designed to develop critical thinking skills be undertaken.

Evaluating the effectiveness of teaching strategies and their impact on critical thinking is important to promote 'best practice'. The purpose of the current systematic review was to determine the efficacy of teaching methods used to develop critical thinking in nursing and midwifery undergraduate students.

Search Strategies Utilised

A search of major databases CINAHL, Ovid Medline, ERIC, Informit, PsycINFO and Scopus, was conducted in October 2015. The search criteria was limited to articles published in English and within

peer reviewed journals for the period 2001- 2015. This timeframe was identified to build on from the publication by Scheffer and Rubinfeld (2000) who used a Delphi study to develop a consensus definition of CT in nursing. It was considered that scholarly research in this area would have occurred following this seminal work.

The inclusion criteria were original research studies that utilised an experimental design to assess CT development following a specific educational intervention in undergraduate nursing and/or midwifery. Papers were excluded if critical thinking was not specifically measured more than once, did not test a specific educational strategy, the sample was post-graduate students, full text was not available in English, discussion papers that did not involve original research study, or did not use an experimental design.

Five search terms were entered into the databases with the article title, abstract and body searched. The search terms used were:

1. "critical thinking" AND midwife*
2. "critical thinking" AND midwife* AND measure*
3. "critical thinking" AND midwife* AND evaluat*
4. "critical thinking" AND students, nursing AND measure*
5. "critical thinking" AND students, nursing AND evaluat*

The search was conducted sequentially using the six databases and search terms. An initial search, filtering for date, language and source of publication, identified 1,315 papers. Following the guidelines suggested by Kable et al. (2012), once duplicates were excluded, each identified citation was reviewed and filtered through three screening levels; (i) title; (ii) title and abstract; and (iii) full-text. Articles that were not relevant or did not meet inclusion criteria were discarded. Twenty-nine papers were included. No papers involving midwifery undergraduate students met the inclusion criteria, therefore the samples of all included studies were undergraduate nursing students.

Each paper was assessed for relevance by reading the abstract (and where necessary the entire paper) using the inclusion and exclusion criteria to assess relevance to this review. Articles that met the inclusion criteria were listed in a summary table (Table 1) during the search. After the initial search all articles identified in subsequent searches were checked against articles in the summary table and duplicates excluded. Each article was also entered into a reference management database (Endnote) including the search term and engine used to locate each article. A quality appraisal process was performed using the Critical Appraisal Skills Programme (CASP) tool (CASP, 2013) and

one article of poor quality was excluded, the excluded study was listed in the summary table. Following the quality appraisal process 28 papers were selected for review.

Results

All 28 included studies involved the measurement of critical thinking skill development or change following completion of a specific educational intervention. The most common educational interventions were problem-based learning (PBL) (7 studies), simulation (6 studies), concept mapping (4 studies), and a combination of PBL and concept mapping (2 studies). The remaining 9 studies examined a diverse range of teaching interventions.

A variety of tools (n=16) were used to measure critical thinking development. Sixteen (57%) of the 28 studies utilised one of three standardised commercially available tools to measure critical thinking. These were the California Critical Thinking Disposition Inventory (CCTDI) (8 studies), the California Critical Thinking Skills Test (CCTST) (3 studies), and Health Services Reasoning Test (HSRT) (3 studies). Two studies used both the Californian Critical Thinking Skills Test and California Critical Thinking Disposition Inventory. A previous systematic review of tools used to measure critical thinking found limited reporting of the reliability of these three tools, little emphasis placed on establishing validity of newly developed tools, and inconsistent results across studies using standardised tools (Carter et al., 2015). Although the results of the studies in this current review could be affected by the reliability and validity of the outcome measures, the focus of this systematic review is to establish the efficacy of different teaching methods in critical thinking development.

Most studies were conducted in the USA (n=13). There was an increasing number of studies from countries where traditional lecture style teaching formats have predominated such as Taiwan (n=4), Korea (n=3), China (n=2), Hong Kong (n=2), Iran (2), Turkey (n=1), and Slovenia (n=1). The results of the papers reviewed will be outlined below and grouped according to the specific teaching strategy utilised.

Title: Efficacy of teaching methods used to develop critical thinking in nursing and midwifery undergraduate students: A systematic review of the literature

Table 1: Articles that met inclusion and quality criteria

No	Author, year and country	Teaching intervention	Participants	Measurement tool Time between pre-post test interventions	Results	Limitations	Quality Appraisal using CASP
Problem Based Learning (PBL)							
1	Choi et al. (2014). Korea	16 week program of PBL compared to traditional lecture	1 st year nursing students (n=90) recruited from 2 colleges. Students from college A received PBL and students from college B received lectures.	Critical Thinking Ability Scale (CTAS) for College Students used at baseline and 16 weeks following instruction.	No significant differences in critical thinking scores between PBL and traditional lecture groups.	Students recruited from two different colleges and may have differed in academic ability. Small sample underpowered study.	Include
2	Jun et al. (2013). South Korea	Intervention group experienced the 5E learning cycle model with PBL for five weeks. Control group received lecture and practice.	1 st year nursing students (n=161)	Critical Thinking Disposition Scale for Nursing Students (CTDS). Pre and post tests performed 4 weeks apart	Statistically significant increase in critical thinking scores for experimental group.	CTDS not available in English, 20 point self report Likert scale measures disposition as a proxy for critical thinking skills. The education intervention was brief, limiting its' impact.	Include
3	Tiwari et al. (2006). Hong Kong	Intervention was a 12 month PBL program. Control group had traditional lectures	1 st year nursing students (n=79).	Californian Critical Thinking Disposition Inventory (CCTDI), at 4 time points, pretest, end of 1st, 2 nd and 3rd years. Qualitative comments were also collected from students.	Significantly greater improvement in critical thinking scores for experimental group on completion of course. Scores still significantly higher after 2 years, although lower than	PBL conducted for one year, perhaps greater differences could have been achieved if continued throughout degree. Could be argued that 1 year was enough to bring about change	Include

					immediately following the program.	Measured critical thinking disposition rather than skill.	
4	Jones, (2008). USA	Intervention of traditional teaching for two weeks and then weekly PBL sessions. Control group received traditional teaching involving pre and post conference lectures.	2nd year nursing students (n=60).	Critical Thinking measured by grading students' written care plans based on 6 levels of Blooms taxonomy of cognitive learning.	Intervention group demonstrated higher critical thinking scores compared to control group.	Potential bias as principal investigator taught both groups, evaluated their work, and was not blinded to the intervention	Include
5	Yu et al. (2012). China	Intervention consisted of PBL, control group received lecture based learning. Timeframe of these approaches was not stated.	2 nd year nursing students (n=76)	Chinese Version of Californian Critical Thinking Disposition Inventory (CCTDI) administered before, after the first learning process (timeframe not stated) and after the semester-long course.	Statistical improvement in overall CTDI scores following PBL. However, PBL students' critical thinking disposition scores did not show improvement on analyticity, systematicity, and critical thinking self-confidence subscale scores.	The subscales of Truth seeking, systematicity, and self-confidence scored below the cut-off of 40, this may be explained by cultural approaches to learning which do not encourage critical thinking Potential contamination of results if students shared learning experiences	Include
6	Dehkordi and Heydarnejad, (2008). Iran	PBL for a one semester course. Control group received traditional lectures.	2 nd year nursing students (n=40)	Californian Critical Thinking Disposition Inventory (CCTDI) given prior to and following the semester.	Statistical improvement in CTDI scores following PBL.	Students may have had limited previous exposure to any active teaching strategies and therefore responded positively to PBL.	Include

7	Yuan et al. (2008). China	Intervention received PBL (36 learning hours, 2hrs x 18 weeks) Control received lectures.	2 nd year nursing students (n=46)	California Critical Thinking Skills Test (CCTST) Chinese-Taiwan Version used at baseline and end of semester.	PBL students had significantly greater improvements on overall CCTST.	Small sample. Involved a single PBL course embedded in a traditional non-PBL curriculum, which might hinder the development of students' critical thinking over time. Potential contamination of results if students shared learning experiences	Include
Concept Mapping							
8	Atay and Karabacak (2012). Turkey	Intervention was 3 x 3-4 hour education sessions on preparing concept map care plans. Control group prepared care plans using the column format.	80 freshman and sophomore nursing students.	Used Californian Critical Thinking Disposition Inventory (CCTDI). Timeframe between pre-post test not stated.	Statistically significant increase in CT scores for experimental group.	Timeframe between pre-post test not stated. Intervention group received an extra 9-12 hours of education compared to control group.	Include
9	Wheeler and Collins, (2003) United States	Intervention involved concept mapping of patient information. Control group taught to use traditional nursing care plans.	A convenience sample (n = 76) was randomly assigned to experimental (n= 44) and control (n= 32) groups.	California Critical Thinking Skills Test (CCTST) given between pre-post tests (7.5 week timeframe).	Significant difference between pre – post test scores for both groups. No difference found between experimental and control groups.	Students exposed to concept mapping for 7.5 weeks which may be insufficient. Only 1/3 of students in one course prepared concept maps. Possible contamination of the 2/3 who did not complete a concept map	Include

10	Lee et al. (2013) Taiwan	Intervention concept map teaching over 15 weeks. Control received traditional lectures.	95 students.	Used Critical Thinking Scale (CTS) at 4 points (beginning of 1 st semester, before the intervention, after the intervention and before graduation).	Both control and experimental groups had higher initial critical thinking scores that tended to decrease over time.	The intervention was only one semester, then teaching reverted to lecturer format. Yet Critical thinking scores were measured for duration of program.	
11	Abel. and Freeze, (2006) USA	Intervention involved student developing 4 concept maps over 4 semesters. No control group.	28 associate degree nursing students.	Used concept map scoring for each of the 4 concept maps completed.	There was a significant increase in mean scores of the first concept map to the average mean score of the last two maps (p=0.05).	Tool measured competence in using a concept map rather than critical thinking. No relationship between measurement tool and critical thinking.	Include
Concept Mapping and PBL							
12	Tseng et al. (2011). Taiwan	Intervention was 3hrs of PBL for 14 weeks and 42 hours of scenario and discussion of concept mapping. Control group received traditional lecture based teaching	120 RN students.	10-item Critical-Thinking Scale (CTS) used before the course began (pre-test), at the end of the course (post-test), and six months after the course (follow-up).	CTS scores were significantly higher in the experimental group at post-test and follow-up.	Promising results regarding retention of higher critical thinking scores following graduation. Potential contamination from students talking to each other about PBL	Include
13	Orique and McCarthy (2015) USA	Intervention 2 sessions of PBL instruction and 1 session of concept mapping in relation to the development of nursing care plans.	1 st year nursing students (n=49)	Holistic Critical Thinking Rubric (HCTR) measured critical thinking in nursing care plans. Students submitted 4 nursing care plans, prior to PBL or concept map teaching, following PBL, following concept mapping and then finally following	There was a significant increase in critical thinking scores across the four nursing care plans submitted.	Results may reflect students' increasing expertise in care planning rather than critical thinking per se. No reporting of inter-rater reliability of the tool. No description of assessment process, and who completed ratings.	Include

				both teaching methodologies.			
Simulation							
14	Sullivan-Mann et al. (2009). United States	Controls received two simulation scenarios. Students in the intervention received five scenarios.	Associate degree nursing students (n=53)	Health Sciences Reasoning Tool (HSRT). 6 week period between pre and post-test.	Statistically significant increase in critical thinking scores for experimental group.	Small sample size, different facilitators for the groups with varied levels of experience. Unclear if controls received any instruction in lieu of the remaining 3 sessions.	Include
15	Ravert, (2008). United States	Two experimental groups (1) 5 sessions in non Human Patient Simulation (HPS) + 5 discussion group sessions + education sessions (2) HPS group –5 patient simulation + education sessions. Control group attended education sessions only.	1 st nursing students (n=30)	Californian Critical Thinking Skills Test (CCTST) and Californian Critical Thinking Disposition Inventory (CCTDI). One semester between pre and post- test.	No differences in critical thinking scores between groups.	Small sample size may limit statistical differences. The critical thinking instruments do not measure concepts related to discipline-specific content. Disparity between intervention vs control dose. Potential contamination from students talking to each other about HPS and what was learnt.	Include
16	Shinnick. and Woo, (2013). United States	Intervention consisted of a single Human Patient Simulation session. No control group used.	3 rd and 4 th year nursing students (n=154) from three Schools of Nursing.	Used Health Sciences Reasoning Tool (HSRT) at baseline and two weeks after a single Human Patient Simulation.	Following HPS there were no statistically significant gains in critical thinking. There was a decrease in scores (not statistically significant).	Very short intervention and assessment timeframe and hence limited ability to impact critical thinking.	Include

17	Wood and Toronto (2012) USA	Intervention group practised critical assessment skills for 2 hours using HPS plus traditional practice (out of class practice with peers). Control group used traditional practice only.	2 nd year nursing students (n=85)	Californian Critical Thinking Disposition Inventory administered 2 weeks prior to and following intervention.	Higher mean post-test total scores compared with pre-test total scores in experimental group students.	The intervention group received an extra two hours of education than the control group. Measured critical thinking disposition rather than skill.	Include
18	Goodstone et al. (2013). USA	Intervention high fidelity patient simulation (HFPS) vs Control consisted of paper-and-pencil case study group work.	1 st semester associate degree nursing students (n=42).	Health Sciences Reasoning Tool (HSRT) used at week 2 and week 14.	There was a significant increase in the HSRT scores for the case study group (p=0.003) but not for the HFPS group.	Small sample size. Students in case study group still received 1 session of HFPS which was originally in the curriculum potentially affecting differences between groups	Include
19	Shin et al. 2015 Korea	Students from University A completed one simulation, Students from University B completed two simulation and C three.	3 rd and 4 th year nursing students (n=237) across 3 universities	Yoon's Critical Thinking Disposition (CTD) tool completed prior to intervention and on completion of paediatric practicum (timeframe not stated)	Students with one or two exposures to simulation did not demonstrate a significant increase in critical thinking scores. Students exposed to three simulations showed a significant increase in critical thinking scores	Differences of teaching methodology between the 3 universities, with one using an integrated curriculum and others using a traditional curriculum. All students had experienced simulation prior to intervention at different degrees. CTD tool was specifically designed for use in Korea and measured disposition only.	Include
Narrative Pedagogy							

20	Evans and Bendel, (2004). United States	Intervention Narrative Pedagogy for one semester. Control consisted of traditional teaching methods (not stated what these were).	Undergraduate nursing students (n=114).	Used Californian Critical Thinking Disposition Inventory (CCTDI) pre and post-test over one semester.	Statistically significant improvement in CCTDI scores for both groups, but no significant differences between control and experimental groups.	Statistically significant improvement for both groups may indicate that involvement in academia increased critical thinking rather than the teaching strategy.	Include
Critical reading and writing course							
21	Chen, and Lin, (2003) Taiwan	Intervention was a 32 hour course in which students learnt literature searching, critiquing and academic writing. It was unclear what education the control group received.	1st year nursing students (n=168)	Used N3 case report accreditation form. Collected data using student's critique of a case study. Data collected at baseline and following completion of the course.	Experimental group reported significantly higher scores than control group.	Unclear whether tool measured students' ability to critique an article rather than critical thinking. 67% of students had previously written a literature review and 79% had written a case study which may have introduced bias. Improvements may be accounted for by repeated exposure to the critique process rather than thinking critically.	Include
Videotaped Vignettes							
22	Chau, et al. (2001). Hong Kong	Intervention was 4 vignettes. No control group was used.	1st and 2 nd year nursing students (n=83)	Pre-test/post-test design using the Californian Critical Thinking Skills Test (CCTST) at baseline and 13 weeks following intervention.	No statistical difference in pre and post test scores.	Students exposed to 4 vignettes over 13 week semester. Low dose may account for the minimal effect on critical thinking skills. No control group for comparison.	Include
Information Communication Technology (ICT) Based Approach							

23	Pucer et al. (2014) Slovenia	Intervention was an ICT program of scenarios that mirror clinical situations. No control group.	1 st year nursing students (n=40).	Used analysis tool of pre and post discussion board postings.	Qualitative analysis of the discussion board posts showed a significant improvement in number of posts (12.2%) for which opinions and conclusions of participants were justified with valid arguments.	Unclear whether tool measured critical thinking or competence in discussion board postings.	Include
Web-Based Animated Pedagogical Agents							
24	Morey, (2012). United States	Intervention online animated pedagogical agent. Control group received traditional face to face teaching.	Final semester nursing students (n=45).	Used the Critical Thinking Process Test (CTPT) a nursing specific quantitative measure and a think-aloud protocol as the qualitative measure. Both measures completed at baseline and 16 weeks later.	No differences in CT levels on either tool.	Limited information regarding the think aloud protocol. Elements seemed to relate to nursing process ie collect, review, relate, interpret, infer, diagnosis, act, and evaluate, rather than critical thinking	Include
Reflective Writing							
25	Naber and Wyatt, (2014) United States	Intervention group completed six reflective writing assignments Unclear what education the control group received.	4 th semester nursing students (n = 70).	Californian Critical Thinking Skills Test and Californian Critical Thinking Disposition Inventory completed at baseline and 8 weeks later.	Total CCTST and CCTDI scores of intervention group did not increase significantly following the intervention. No reporting of reliability of CCTST or CCTDI scale for this study.	Only eight weeks between pre and post test. Perhaps critical thinking takes longer than 8 weeks to develop. Potential contamination if students discussed their learning.	Include
Grand Rounds							
26	Mann, (2012). USA	Students resolved a healthcare dilemma as a group following a simulation	2 nd year nursing students (n = 21).	Assessment Technologies Institute (ATI) Critical Thinking Assessment (CTA) at commencement of	No significant difference between CT scores for the two groups. Students in control group reported	The educational intervention was not clearly described. Very small sample size. As critical thinking initially	Include

		technique. The education strategy appears to be grand rounds but not specified. Control condition not specified.		program and at completion of course.	decreased critical thinking ability.	measured at beginning of program rather than immediately prior to the intervention other variables/factors could have affected critical thinking skills.	
Interactive Videodisc System (IVS)							
27	Yeh and Chen (2005). Taiwan	Educational intervention - 2 hour lecture on critical thinking and an optional IVS program.	RN-BN students (n=126) enrolled in a medical-surgical course.	Californian Critical Thinking Disposition Inventory (CCTDI) at baseline and 6 weeks later following the course.	Statistically significant differences between pre and post-test overall scores.	Only measured critical thinking disposition rather than CT skills. IVS participation ranged from 15 to 150 minutes. Did not correlate changes in CCTDI with time spent on IVS.	Include
Evidence-Based Nursing Education Course							
28	Zadeh et al. (2014). Iran	Intervention research methodology and evidence based nursing course. Control condition not described.	3rd year nursing students (n=48).	Used Californian Critical Thinking Disposition Inventory (CCTDI) prior to intervention and one month later.	CCTDI scores were significantly higher in intervention group.	Low pre and post test scores (means of 26 and 36). Relevance to other countries may be limited.	Include
Peer Active Learning Strategies Approach (PALS)							
29	Stevens et al. (2009) USA	Peer active learning strategies approach (PALS). No control group.	Undergraduate nursing students (n=15)	Critical Thinking Likert Scale (CTLTS) completed prior to and following clinical experience (no timeframe given).	Increase in scores on CTLTS but no statistical analysis performed. No reporting of reliability of CTLTS for this study or previously.	No information provided on recruitment of sample. No validity or reliability testing of tool. Very small sample size.	Exclude. No statistical analysis. Descriptive design. Tool validity and reliability unknown.

Teaching strategies

Problem Based Learning

Seven studies measured the effects of problem based learning (PBL) on the development of critical thinking (Choi, et al., 2014; Tiwari, et al., 2006; Jones, 2008; Jun, et al., 2013; Yu, et al., 2012; Yuan et al., 2008; Dehkordi and Heydarnejad, 2008). Two studies measured the effect of both PBL and concept mapping on critical thinking (Tseng et al., 2011; Orique et al., 2015). All but one study (Choi et al, 2014) found PBL to have a positive effect with an increase in critical thinking scores. Three studies that tested a PBL intervention used the CCTDI to measure critical thinking change. In a 2-year longitudinal study students in the intervention group experienced PBL for an academic year (Tiwari et al., 2006). Students receiving the intervention had significantly higher overall CCTDI scores which they attributed to PBL. Similar results were obtained by Yu et al. (2012) and Dehkordi and Heydarnejad (2008) who also used the CCTDI to measure the effects of PBL on critical thinking. However, Yu et al. (2012) found no differences in the subscale scores related to analyticity, systematicity, and self-confidence. The conflicting results between these studies using the same intervention and tool may indicate a lack of sensitivity by the CCTDI to measure critical thinking change in nursing practice. The CCTDI relies on self-report which may be affected by social response bias (Tiwari, et al, 2006). Furthermore, the CCTDI measures student's critical thinking disposition, or the self-perceived likelihood of them thinking critically, whereas critical thinking is considered to have two dimensions; disposition and skills (Facione, 1990). The increase in critical thinking disposition may not translate into the application of critical thinking skills in nursing practice.

Seven of the nine studies involving PBL were conducted in Asian and Middle Eastern countries (Korea, Hong Kong, Taiwan, China and Iran), where cultural influences may adversely affect critical thinking development of students. According to the recommended minimum cut-off scores on the CCTDI, scores between 30 and 40 indicates "weakness to ambivalence" towards that critical thinking domain (Facione and Facione, 1992). In two of the three PBL studies using the CCTDI (Tiwari, et al., 2006; Yu, et al.,2012), domain scores did not reach the cut-off score of 40 in either pre or post-tests, indicating a weak critical thinking disposition. This may be indicative of cultural influences in those Asian countries. Predominant characteristics of learning environments in Asia such as adherence to didactic models of teaching, dominance of the medical model, and not questioning those in authority, do not foster independent thinking (Lim et al., 2009; Chan et al., 2011). Thus, the applicability of results from these studies to other cultures where students are encouraged to

question and think independently may be limited. Nevertheless, these studies do provide a baseline from which future studies in those countries may demonstrate general improvement.

The impact of culture on different learning environments may also influence teaching approaches. In four of the nine studies related to PBL students had previously only been exposed to didactic teaching methods (Dehkordi and Heydarnejad, 2008; Jun et al., 2013; Tiwari et al., 2006; Yuan, et al., 2008). Didactic teaching promotes rote learning and offers little opportunity for students to question and consider the application of nursing knowledge to practice. Although results from four studies were favourable, PBL was the only active learning approach students had experienced. The increase in critical thinking scores may simply reflect encouragement by teachers for students to think actively.

Critical thinking skills were found to improve in the intervention group following PBL, measured through grading of developed nursing care plans (Jones, 2008). However, it was not clear whether the tool used to grade the care plans was validated by experts or if the items measured dimensions of critical thinking. Methodological rigour is questionable as the principal investigator taught both groups, and graded the care plans, introducing potential bias.

The use of both PBL and concept mapping on critical thinking was examined in two studies (Tseng et al., 2011; Orique et al., 2015). Students receiving PBL and concept mapping reported significantly higher Critical Thinking Scale (CTS) scores upon completion of course and 6 months later (Tseng et al., 2011). There was limited information regarding the CTS tool and how it measured critical thinking. However, promising follow-up results suggested that PBL was an effective long term strategy to increase critical thinking in this cohort. As this study was conducted in Taiwan, baseline levels of critical thinking may have been low, small changes may have been significant, and culture may have contributed to positive results.

Orique et al. (2015) measured the effects of PBL and concept mapping separately on critical thinking using the Holistic Critical Thinking Rubric (HCTR). Students submitted nursing care plans prior to and following, PBL instruction and concept mapping sessions. The significant increase in critical thinking scores across time for these first year students could have related to students' developing care planning expertise rather than improved cognitive skills. The assessment process was not well described; there was no detail on whether assessment was undertaken by a lecturer who was blind to the intervention; and if teachers' ratings of students work were moderated.

The effect of PBL on critical thinking development appears favourable, with seven of the nine studies reporting positive outcomes. However, due to the use of different measurement tools (some of which had not been validated), different cultural influences on critical thinking development and learning approaches, and lack of methodological rigour, these results need to be viewed with caution. None of the included studies provided sufficient descriptions of PBL processes to ensure fidelity and enable replication by other researchers. There was no information on the preparation of staff to teach PBL methods and no quality review of classroom processes reported such as the extent to which students were encouraged to question, the extent to which teachers facilitated rather than lead learning; ability of students to work together to generate new knowledge, quality of the case studies and quality of supplementary resource materials for each case.

Concept mapping

Four studies measured the effect of concept mapping on critical thinking. Three studies (Atay and Karabacak, 2012; Lee et al., 2013; Abel and Freeze, 2006) found an increase in CT scores following concept mapping education and activities. The effects of preparing care plans using concept maps on critical thinking was measured using the CCTDI (Atay and Karabacak, 2012). Students receiving the intervention had statistically significant higher critical thinking scores and mean scores on concept map care plan evaluation criteria. However, there were inconsistencies in the length of the educational intervention, with the intervention group receiving an extra nine to twelve hours of education specifically on concept mapping. The increase in critical thinking scores could have been a result of extra educational hours rather than as a direct result of the concept mapping education.

A two year longitudinal study tested the effects of concept map education on critical thinking skills using the Critical Thinking Scale (CTS) at four time-points. The CTS measures critical thinking through assessment of inference, recognition of assumptions, deduction, interpretation, and evaluation of argument concepts (Lee et al., 2013). The 15 week course on concept mapping produced an initial improvement in critical thinking scores but this decreased over time for all students. The results may indicate that the intervention was not integrated or impactful as students experienced didactic teaching methods for the remainder of the program.

Another longitudinal study evaluated the effects of concept mapping with 28 associate degree nursing students (Abel and Freeze, 2006). A validated concept map scoring criteria was used to measure critical thinking development at four time-points over a one year period (Abel and Freeze, 2006). The authors demonstrated increases in students' concept map scores as they progressed through the curriculum. However, it was unclear how the scoring criteria related to critical thinking

and whether increased scores were a true reflection of improved critical thinking or simply improved competence in concept mapping.

Wheeler and Collins (2003) did not demonstrate the same effect in their 7.5 week study. Pre and post test scores on the California Critical Thinking Skills Test (CCTST) of students taught concept mapping compared to a control group who received instruction on preparing traditional nursing care plans did not differ. Increased critical thinking scores were discerned in both groups, with no difference between groups. This suggests that both teaching approaches were effective in increasing critical thinking development.

Simulation

Six studies examining the effects of simulation on development of critical thinking had variable findings. Two studies reported increased critical thinking scores following the intervention (Sullivan-Mann et al., 2009; Wood and Toronto 2012). Shin et al., (2015) found the increase in critical thinking was dose dependent, with increases in scores occurring with three simulations but not with two or one. Another study demonstrated no increase in critical thinking scores, and some decreases (Shinnick and Woo 2013), while another study found higher scores in the control group (Goodstone et al., 2013). The final study which used two outcome measures reported contradictory findings between tools (Ravert, 2008).

The effect of multiple simulations on critical thinking over a period of six weeks was measured using the HSRT (Sullivan-Mann et al.,2009). Groups were exposed to two (control) and five (intervention) clinical simulations. Although both groups had increased scores on the post-test, the intervention group had statistically higher scores. The authors suggested results may have been affected by the experience of the clinical facilitator (Sullivan-Mann et al., 2009).

Another study tested a brief intervention involving a single human patient simulation with a two week lapse between pre and post-test using the HSRT (Shinnick and Woo, 2013). There was a decrease in critical thinking scores, perhaps related to response burden. The HSRT takes 40-50 minutes and asking students to complete this tool twice in two weeks may have been time intensive particularly in response to a low-dose intervention. In contrast, a brief two hour human patient simulation intervention with the same two week timeframe between testing resulted in higher mean post-test scores for the experimental group using the CCTDI (Wood and Toronto, 2012). The CCTDI takes around 20-30 minutes to complete. As the HSRT measures the application of critical thinking and the CCTDI measures student's disposition for critical thinking, differences in results in these two

studies could suggest that a short intervention may influence a change in students' tendency to think critically but does not change their ability to apply critical thinking skills.

To test the effect of simulations on critical thinking Shin et al. (2015) used a multisite approach where one site offered one simulation, another offered two simulations and the third site conducted three simulations. Improved critical thinking scores were only noted for the students who participated in three simulations. It was not clear whether students who participated in fewer sessions still received teaching for the same length of time. Results could also have been affected by different teaching approaches at the three universities with one using an integrated curriculum and the other two using a traditional one. A potential limitation of the study was that the Critical Thinking Disposition (CTD) tool measures students' disposition whereas simulation requires the practical application of critical thinking skills. The CTD was specifically designed for use in Korea and items may not be applicable to education in other countries.

Ravert (2008) used the CCTST and CCTDI to measure critical thinking development in undergraduate nursing students allocated into simulation (5 hours), non-simulation (5 hours) and control groups. The control group demonstrated higher scores on the CCTDI compared to non-simulation and simulation groups whereas the two intervention groups scored higher on the CCTST. Differences in scores did not reach statistical significance as the small sample (n=30) size may have been under-powered to detect group differences.

Contradictory results were also found in a study comparing the effect of high fidelity patient simulation to case study teaching (Goodstone et al., 2013). The post-test HSRT administered 14 weeks later revealed significantly higher scores for the case study group compared to the high fidelity patient simulation group. Results may have been affected by the small sample size (n = 42), and possible contamination as the case study group experienced one simulation session as well.

Contradictory findings were demonstrated by the five studies measuring the effect of simulation on critical thinking. Three studies utilised the HSRT and found inconsistent results. The effect of simulation on critical thinking is uncertain and may have been affected by the relatively short intervention dose and short timeframe between pre and post-testing. Critical thinking is considered by some to be an 'ingrained' trait (Ravert, 2008) and take significant time to change or develop (Choi, 2014). Thus a short intervention may not be adequate to impact on critical thinking abilities.

Narrative Pedagogy

The effect of narrative pedagogy on critical thinking development was examined over one semester using the CCTDI (Evans and Bendel, 2004). Critical thinking scores were expected to increase based on results of a five year project on narrative pedagogy which demonstrated improved integration of theory with practice, and empowerment as clinicians (Severtsen and Evans 2000). However, although critical thinking scores improved for both groups, no statistical differences between the control and experimental groups were noted. It could be that critical thinking disposition increases in an excellent academic environment regardless of the teaching strategy.

Critical reading and writing course

The N3 case report accreditation form developed by the Taiwan Nurses Association was used to assess students' critical thinking abilities in the critique of case study reports (Chen and Lin, 2003). Students in the intervention group received education on the process of literature searching, critical reading and writing. Students in the experimental group had significantly higher case study scores than the control group. Improved scores by the experimental group may be accounted for by their repeated exposure to the critique process and may reflect their improved ability to critique an article rather than think critically.

Videotaped vignettes

The effect of videotaped vignettes on critical thinking skills for 1st and 2nd year students was measured using the CCTST (Chau et al., 2001). There was no control group and no statistical difference was found between pre and post test scores. Although the course was conducted over 13 weeks, students were only exposed to 4 vignettes in this period. Intervention dose may have been insufficient to develop students' capacity to address problems that were new to them (Chau, et al., 2001).

ICT based modern approach

Pucer et al. (2014) used a newly developed discussion board analysis tool to identify core key elements of critical thinking as defined by Facione (1990). A significant improvement in the percentage of posts where students' opinions and conclusions were justified with valid arguments was reported (Pucer et al., 2014). However, there was limited information on development of the tool, process of expert review and validation, or inter-rater reliability. It was unclear whether the tool measured student's critical thinking abilities or their competence in discussion board postings.

Web-based animated pedagogical agents

Both a newly developed qualitative tool using a think aloud protocol, and a standardised tool named the Critical Thinking Process Test (CTPT) were used to measure the effects of an animated pedagogical agent on critical thinking (Morey, 2012). Results differed according to the tool used. Although both groups improved there were no significant differences on CTPT scores and correct conclusions using the think-aloud protocol. The pedagogical agent group had significantly better results on the cognitive process of evaluation. These mixed results may indicate the difficulty in measuring critical thinking development in an exam context.

Reflective writing intervention

An eight week reflective writing intervention was used with 70 fourth semester students randomised into control and intervention groups (Naber and Wyatt, 2014). No statistically significant increases in critical thinking scores using the CCTDI and CCTST were demonstrated in the intervention group and there were no differences between groups.

Grand rounds

The effectiveness of a 'grand round' education strategy on critical thinking was assessed using the CTA (Mann, 2012). No statistical differences between intervention and control groups were found however the intervention group improved more. The intervention group received more hours of education and instruction from the researcher which could have affected results. Also the pre-test was conducted at the beginning of the program rather than immediately prior to the intervention so results may have been confounded by variables not considered in this study.

Interactive videodisc systems (IVS)

A brief intervention consisting of a two hour lecture and an optional interactive videodisc system (IVS) produced increased scores on the CCTDI with 6 weeks between pre and post-test (Yeh and Chen, 2005). However, student participation in the interactive videodisc system ranged from five to 150 minutes. It would have been useful to correlate changed CCTDI scores with duration of participation with the interactive videodisc system. The increased scores may have also been affected by cultural influences as four of the seven pre-test domain scores and one post-test domain did not reach the minimum cut-off score of 40, indicating weak baseline critical thinking disposition in students.

Evidence based course

A study in Iran examined the effects of an evidenced based nursing course reported improved CCTDI scores (Zadeh et al., 2014). However, the low mean pre and post-test scores on the CCTDI (means of

26 and 36 retrospectively), indicated improved, but still weak critical thinking disposition in students. This may relate to Iranian culture where nursing education methods concentrate on memorisation of facts. Prior to this course students had only been exposed to didactic teaching methods (Zadeh et al., 2014). The relevance of these findings is limited in other countries where evidence based education is embedded within curricula.

Discussion

This review included 28 studies from 8 different countries testing 12 different teaching interventions to promote the development of critical thinking. None of the included studies involved midwifery students and highlights a significant gap in midwifery education literature. The findings of the review also need to be considered in light of limitations associated with methodological rigour, cultural influences, appropriateness of the measurement tool, duration of intervention, timing of pre and post-testing, and intervention versus control dose.

Results of included studies varied, with little consistency across studies using the same type of intervention or outcome tool. Seventeen studies identified a significant increase in CT of nursing students following an educational intervention, while nine reported no increases and some found unexplained decreases in critical thinking. In four studies the education intervention was longer than the control condition (Ravert, 2008; Atay and Karabacak, 2012; Wood and Toronto, 2012; Mann, 2012). These discrepancies in 'dose' across conditions may have biased results.

Critical thinking in these nursing studies was often measured following a single brief intervention (Shinnick and Woo, 2013; Wood and Toronto, 2013; Sullivan-Mann et al., 2009; Ravert, 2008; Yeh and Chen, 2005) with limited success. Given that critical thinking is considered to develop over time (Paul, 1993; Choi et al., 2014), the length of an intervention is an important educational and research consideration. Other methodological weaknesses related to the timing of pre and post-test measurement which ranged from 2 weeks to 4 years. A short testing interval may not only result in survey fatigue but only reflect short-term improvement of critical thinking due to new learning. Sustained longer term effects were rarely assessed. Interventions are more likely to successfully develop critical thinking if offered over an extended period of time, there is a progressive scaffolding of skills; educators are competent to offer the intervention, and interventions are integrated throughout the curriculum.

Promising results were found on the effects of PBL and concept mapping on critical thinking development. This is not surprising given the constructivist principles underpinning these teaching

methodologies. PBL and concept mapping challenge students to actively participate in building knowledge from what is known towards a new understanding (Piaget, 1977; Vygotsky, 1986). Although the construction of new knowledge commonly involves engagement in research activities, and the use of intelligence and reasoning, the co-operative and interactive nature of problem based learning fosters students' critical thinking in relation to clinical problems.

Variable results were found on critical thinking development when using simulation. Inconsistencies in the intervention dose and small samples sizes could account for some of this variation. However, using simulation as a teaching strategy to improve critical thinking requires further investigation. According to Mong-Chue (2000) critical thinking involves controlled, purposeful and conscious thought processes. Although simulation activities can be useful in developing clinical skills it is uncertain whether they develop critical thinking skills which involves the interpretation of multiple data sources (Mitchell et al., 2009). Within clinical simulation students are often required to make rapid decisions, critical thinking requires a deeper learning methodology using analytical skills and analytical skills and acumens beyond this (Carter et al., 2014).

Positive and promising results were found with a small number of studies using other interventions including; the use of discussion boards, critical reading and writing courses and narrative pedagogy, which require further investigation. Positive findings related to these interventions could be due to the use of active constructivist-based learning strategies.

The increases in critical thinking performance can be understood more readily by exploring cognitive development theories by researchers such as Piaget (1977) and Vygotsky (1986). When students engage in a clinical problem which cannot be easily resolved cognitive dissonance occurs. Active learning strategies such as PBL, concept mapping and simulation framed around clinical scenarios, enable students to further construct their knowledge in relation to the concepts in question. Constructivist learning is enhanced by using experiential learning methods (such as simulation) and peer interaction (during PBL) which promotes cognitive development because of discussion around critical cognitive conflicts. Given that constructivists see learners as constructing their own knowledge, more attention also needs to be paid to learning from experience (Boud & Edwards, 1999).

Some results of this review may have been influenced by possible cultural influences. Seven studies using PBL and one testing concept mapping were conducted in Asian and Middle Eastern countries where didactic methods are the norm. Passive learning through lectures is well known to limit

critical thinking development as it focusses on the memorisation of content (Diekelmann and Smythe, 2004; Ironside, 2004). It could be that any type of active teaching strategy will increase critical thinking disposition and skill scores in these circumstances. The evaluation of similar strategies in countries where a diverse range of teaching methods are used may not achieve the same level of change in critical thinking development.

Educational and practice contexts in countries such as the United Kingdom, United States and Australia reflect a wide variety of active teaching and assessment strategies. Increasingly, midwifery and nursing programs in Australia involve blended and online learning. Rather than using one specific teaching or learning strategy, a scaffolded approach of active learning and authentic assessment, including clinical assessment is used (Carter et al., 2014). Assessing the development of critical thinking in these programs would require longitudinal, multi-method measurement. Many studies in the review used brief teaching and learning interventions which had limited impact on nursing students' critical thinking. Raymond-Seniuk and Profetto-McGrath (2011) suggest pluralism or multiple lenses are also needed to capture the depth and breadth of the knowledge and essence of midwifery and nursing practice. The use of multiple outcome measures and triangulation of data may provide greater insight into the effectiveness of teaching methods on critical thinking. Such approaches may also contribute to the development of critical thinking methodologies specifically in nursing and midwifery. Understanding and testing the theories underpinning different teaching interventions is needed in order to continue advance our knowledge in this field.

The review itself was limited to empirical studies published in English that used measures of critical thinking with midwifery and nursing students. It could be that these criteria unnecessarily restricted the scope of the review. Future reviews could consider an evaluation of teaching interventions to promote critical thinking across health professional groups. Given the high proportion of researchers using the California Critical Thinking Disposition Inventory (CCTDI) (8 studies), the California Critical Thinking Skills Test (CCTST) (3 studies), future reviews could also consider a meta-analysis of results from these tools across a broad range of health professional students. However, it could also be argued that the continued use of generalised critical thinking tools is unlikely to help identify appropriate teaching methods to improve critical thinking abilities of nursing and midwifery students. Discipline specific strategies and tools that measure the student's ability to apply critical thinking in practice are needed.

Conclusion

Common educational interventions used to promote critical thinking development were PBL, simulation, and concept mapping. There were methodological concerns about most studies such as small sample size and a lack of quality assurance on the delivery of an intervention. The short duration of interventions did not allow sufficient time for students to develop critical thinking skills. Variability in the timing between pre and post-tests was evident, with the majority of studies repeating the outcome measures soon after the completion of the intervention. Longer term effects of interventions on critical thinking were rarely reported. There were also inconsistencies in intervention and control doses and in some studies, the control group experienced smaller doses, introducing potential bias. In some studies, these factors were confounded by cultural influences on critical thinking development.

Academics need to continue to strive to maximise student's critical thinking abilities, preparing them to be competent, effective and autonomous nursing and midwifery graduates. Whilst this review aimed to identify effective teaching strategies that promote and develop critical thinking, flaws in methodology and outcome measures contributed to inconsistent findings.

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