REVIEW PAPER

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What methods are being used to teach clinical reasoning in physical therapy education and are they effective? A systematic review of literature

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Melissa Cencetti[1], Laurie Brogan[1], Anthony F. Carusotto[2], Kristen Karnish[1]
[1] Physical Therapy Department, Misericordia University, Dallas, PA, USA
[2] Physical Therapy Department, University of Scranton, Scranton, PA, USA

Abstract

Introduction. Development of clinical reasoning (CR) is a critical skill for physical therapy (PT) students. A consensus of the most effective way to teach CR is lacking. The purpose of this study was to identify educational methods that PT education programs in the United States and abroad are utilising to develop CR skills and compare the effectiveness of those methods.
Methods. Preferred Reporting Items for Systematic Review (PRISMA) guidelines were followed. A literature search was conducted in September 2021 and March 2022 in the following databases: PubMed, CINAHL, Health Source: Nursing/Academic Edition, and Academic Search Ultimate (EBSCO). Articles that investigated instructional methods used to teach and measure CR in PT students were included. Data extracted included instructional method details and results of outcome measures used to assess CR.
Results. Of 324 articles, 12 met eligibility. Instructional methods included simulated patients (n = 3), case activities (n = 6), patient care activities (n = 2), and curriculum design considerations (n = 2). Results suggested that CR performance improved with all but was better when students worked in dyads or groups (n = 3). A variety of outcome measures were used to assess CR, the majority relying on student self-assessment of CR skills.
Conclusions. This systematic review illustrates great variety in the methods used to teach and measure CR in PT education, all of which resulted in improved CR. Further research comparing the effectiveness of teaching methods and the reliability and validity of outcome measures of CR is needed.
Key words: clinical reasoning, teaching, physical therapy

Introduction

Clinical reasoning (CR) is an essential skill that allows health care professionals to provide optimal quality care. The development of this skill leads to more appropriate decision-making and effective outcomes. Literature searches in medicine, nursing, physical therapy, and occupational therapy education all indicate that CR is a topic of interest. The American Council of Academic Physical Therapy (ACAPT) has a consortium dedicated to developing an understanding of CR, along with providing support to educators on best practice methods of teaching and assessing CR [1]. Yet, there does not seem to be any consistency nor agreed upon methods to accomplishing the educational goal of improved decision-making in clinical settings. Part of this problem may be related to the lack of consensus on the definition of clinical reasoning. In a scoping study that reviewed 625 papers from 18 health professions, 110 terms for clinical reasoning were identified [2]. This lack of consensus can result in inconsistencies in teaching and assessment, which creates challenges in developing competency frameworks. Research has suggested that this 'fragmentation' of the construct of CR may be the result of different boundary conditions [3]. Some researchers use human cognition limits and others use contextualised reasoning approaches, in which case there may be irreconcilable differences in knowledge, set conditions, and theoretical frameworks [3]. Again, this emphasises the importance that the underpinnings of CR are explicit and clearly stated.

Clinical reasoning is difficult to teach, possibly because it is complex, fluid, and context-dependent. ACAPT describes clinical reasoning as a cognitive, psychomotor and affective skill [1], which only complicates the process more. Knowledge-level learning alone will not equate to appropriate CR, nor will being competent in a laundry list of skills. Both of those characteristics are relatively concrete, important, and manageable to teach. However, there is an abstract, less quantifiable quality that the practitioner must possess in order to demonstrate appropriate affective skills along with accurate judgement of the personal and environmental context. ACAPT has listed 11 categories of reasoning that physical therapists may utilise during a single patient session, which include: diagnostic reasoning; narrative reasoning; procedural reasoning; interactive reasoning; collaborative reasoning; reasoning about teaching; predictive reasoning; ethical reasoning; intuitive reasoning; dialectical reasoning; and non-analytical reasoning [4].

Previous literature in physical therapy strongly supported the need for a comprehensive knowledge base to engage in effective CR, specifically suggesting that the teaching environment should be based on adult learning theories that encourage learner self-direction and responsibility [5]. Proposed teaching methods included small-group activities such as role playing, practice thinking and communicating, and video simulation, so that students can see the value of making a conscious effort to engage and practice CR. However, these traditional approaches focus on broad steps that students find difficult because it is not concrete or visible to them. 'Making Thinking Visible' is a teaching method that can be used to bridge the gap between the abstract and concrete [6]. It involves clinical educators identifying what they know, how they are thinking, and the connections they are making

Correspondence address: Anthony F. Carusotto, University of Scranton, 800 Linden Street, Scranton, PA. 18510, USA,
e-mail: anthony.carusotto@scranton.edu; https://orcid.org/0000-0002-2406-2316

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in a four-step process that includes: articulate; make the concrete visible; refine, chunk, sequence; and enculturation. Experienced clinical educators have trouble teaching CR because their CR process is an inherent way of thinking, so making expert clinical reasoning visible can be a legitimate way to teach novice students to use clinical reasoning in different clinical situations [6].

This topic is of clinical significance to physical therapists. With evidence available to support the efficacy of specific instructional methodologies in teaching CR to PT students, educators could design curricula to provide students with a clear road map to develop these important skills. This would promote consistency within and between programs and would allow for better communication between the clinical and academic faculty. Ultimately, this would better prepare students to provide efficient, cost-effective patient care. The purpose of this study was to investigate educational methods utilised in physical therapy education programs to promote CR and their impact on developing CR skills and performance.

Subjects and methods

This systematic literature review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. A literature search was conducted in September 2021 and in March 2022 using the Medical Subject Headings (MeSH) terms of clinical reasoning [All Fields] AND teaching [All Fields] AND physical therapy [All Fields]. The following databases were searched: PubMed, CINAHL, Health Source: Nursing/Academic Edition, and Academic Search Ultimate (EBSCO), which includes a collection of dozens of databases that cover a multitude of subjects and disciplines. Inclusion criteria for this review included articles that investigated instructional methods used to develop and measure CR in physical therapy students in educational programs in the United States and abroad. Exclusion criteria included duplicated results, unavailable full texts or abstract only, systematic reviews, studies not including physical therapy students, non-English papers, and studies not including an outcome measure for CR. The primary outcomes of interest were instructional methods used to teach CR and an outcome measure to assess CR in PT students. Secondary outcomes included the type (individual, dyad, or group) and duration of the instructional method. The outcome measures that were used to measure clinical reasoning in each study were used to determine the effectiveness of the instructional methodology.

During the initial identification and screening process, an initial review of titles, keywords, and abstracts was conducted by one researcher (MC), and articles were excluded because of a lack of relevance to CR in PT students. The remaining articles were divided in half, and an eligibility assessment was then performed by paired researchers (LB & AC; KK & MC) who independently reviewed the titles and abstracts to determine relevance based on the established inclusion and exclusion criteria. Discussion was used to attain consensus when there were disagreements between the pairs. All four researchers convened to discuss the articles selected for the final sample prior to beginning the data collection process. Included abstracts were then subjected to full text review independently by the paired researchers. Again, consensus was attained through discussion. Paired researchers extracted data from the included studies and cross-checked to review accuracy based on relevance to the research question. Extracted data was collected in a matrix that included: (1) study methodology; (2) study participants; (3) instructional methods and assessment tool(s) used to measure CR; (4) study outcome measures and recommendations; and (5) study limitations and conclusions. Again, discussion amongst the researchers assured accuracy and agreement.

The included articles were then assessed for methodological quality in order to provide transparency regarding article characteristics. All quantitative studies were analysed using the Medical Education Research Study Quality Instrument (MERSQI) score, and all qualitative studies were analysed using the Critical Review Form: Qualitative Studies (version 2.0). The MERSQI was developed in 2007 as a tool to examine medical education research. It has been found to have good inter-rater reliability and excellent intra-rater reliability [7]. It evaluates study quality based on 10 items: study design, number of institutions studied, response rate, data type, internal structure, content validity, relationship to other variables, appropriateness of data analysis, complexity of analysis, and learning outcome. The 10 items are organised into six domains, each with a maximum score of 3 and a minimum score of 1. Not reported items are not scored, resulting in a maximum MERSQI score of 18. While there are no specific values assigned to determine high or low quality, higher MERSQI scores indicate greater use of preferred methodological procedures [7].

The Critical Review Form: Qualitative Studies (version 2.0) was initially developed by the McMaster University Occupational Therapy Evidence-Based Practice Research Group and later revised by Letts et al. [8] to be used to critically review qualitative literature. The form descriptively assesses the following study components: aims of the research, methodology, research design, recruitment strategy, data collection methods, relationship between researchers and participants, and ethical considerations. Although the Critical Review Form: Qualitative Studies (version 2.0) does not provide a score, it does provide a systematic way to review and to evaluate the trustworthiness of qualitative articles. Neither review form was used for inclusion/exclusion scoring, but rather to review and share methodological quality rigour. Each of the paired reviewers (LB & AC; KK & MC) analysed and scored half of the articles. If agreement for the level of evidence could not be reached, the other pair was consulted and consensus was attained through discussion. Both the MERSQI and The Critical Review Form: Qualitative Studies (version 2.0) were determined to be appropriate tools to use for a literature review related to physical therapy education.

Ethical approval

The conducted research is not related to either human or animal use.

Results

A total of 324 articles and abstracts were identified from the September 2021 and March 2022 electronic database searches. Of these, 260 articles were excluded because the titles or abstracts did not align with the research question or because they were duplicates. This left 64 full-text articles reviewed for inclusion or exclusion criteria. Fifty-two of the 64 articles were excluded. Data was extracted from the 12 remaining studies about the study methodology, participants, intervention characteristics, outcomes, conclusion, and limitations and each was cross-checked to review the accuracy (Figure 1 and Table 1).

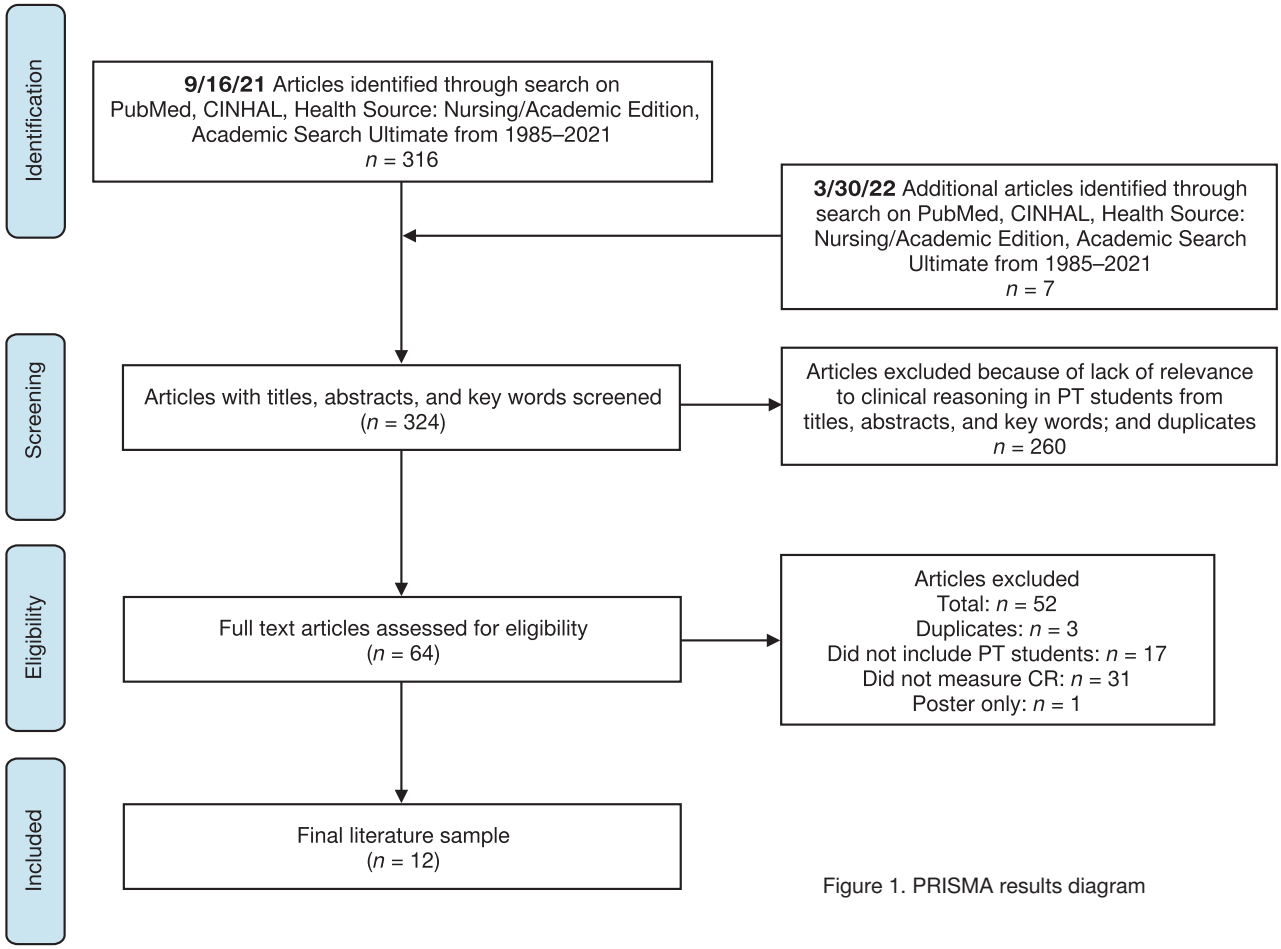

Figure 1. PRISMA results diagram

Table 1. Database search results

Identification			Screening		Eligibility	
Database	Data	Results	Excluded	Included for eligibility assessment	Excluded	Included for final literature sample
PubMed	9/16/21	192	162	30	During the eligibility assessment, articles were not separated by database, but by date. The 9/16/21 search resulted in 3 duplicates; 17 did not include PT students; 1 was a poster only with no full article; 27 did not specifically measure CR. The 3/30/22 search resulted in 4 that did not specifically measure CR.	
	3/20/22	4	0	4		
CINAHL	9/16/21	62	43	19		
	3/20/22	0	0	0		
Health source: nursing/ academic edition	9/16/21	29	24	5		
	3/20/22	0	0	0		
Academic search ultimate	9/16/21	34	31	3		
	3/20/22	3	0	3		
Total	9/16/21	317	260	57	48	9
	3/20/22	7	0	7	4	3

CR – clinical reasoning

Study characteristics

Of the 12 articles selected for this review, 10 were quantitative studies [9–18] and 2 were qualitative studies [19, 20]. The quantitative studies included 1 randomised controlled trial, 5 pretest/posttest design studies with control, and 4 posttest design studies with no controls. The number of participants in each study ranged from 12 to 332, with the median number of participants being 62. Eleven of the studies assessed only PT students, while 1 study assessed PT along with students from other allied health professions including medicine, pharmacy, occupational therapy and physician assistant [9]. Four of the studies involved 'pre-clinical' PT students [9, 12, 14, 18]; 1 study involved 'pre-clinical' MPT students [10]; 3 studies involved final year DPT/PT students [11, 15, 20]; 2 studies involved undergraduate PT students

Table 2. Medical Education Research Quality Instrument (MERSQI) for quantitative studies

Domain (score range)	Study design (1–3)	Sampling (1–3)	Type of data (1–3)	Validity of evaluation instrument (0–3)	Data analysis (1–3)	Outcomes (1–3)	Total score
Elvén et al. [15]	2	2	3	2	3	1	13
Gillardon and Zipp [10]	3	1	1	0	2	1	6
Ladyshewsky [11]	2	2	1	2	3	1.5	11.5
Montpetit-Tourangeau et al. [16]	2	0.5	1	0	3	1.5	8
O'Dell et al. [13]	1	1	1	0	2	1	6
Seif et al. [12]	1.5	2	1	3	2	1	10.5
Seif et al. [9]	2	2	1	3	3	1	12
Trommelen et al. [18]	1.5	2	1	1	3	1	9.5
Willis et al. [14]	1.5	0.5	3	1	3	1	10
Yaqoob et al. [21]	1	2	1	0	2	1	7

Score range is from 5 to 18. Adapted from: Reed et al. [22].

Table 3. Critical review form: Qualitative Studies (version 2.0)

	LaRosa and Dinsmore, The effect of case presentation on student physical therapists' clinical reasoning hypotheses [20]	Ladyshewsky, A quasi-experimental study of the differences in performance and clinical reasoning using individual learning versus reciprocal peer coaching [11]
STUDY PURPOSE:		
Clearly stated?	yes	yes
LITERATURE:		
Relevant background literature reviewed?	yes	yes
STUDY DESIGN:		
Appropriate for the study?	yes	yes
Theoretical perspective identified?	yes	yes
SAMPLING:		
Process described?	yes	yes
Sampling done until redundancy in data reached?	no	no
Informed consent obtained?	yes	yes
DATA COLLECTION:		
Clear and complete description of site/participants?	yes	yes
Clear and complete description of the role of researchers?	yes	yes
Clear and complete description of the relationship with participants?	yes	yes
Clear and complete identification of assumptions and researcher bias?	yes	yes
Procedural rigour used in data collection strategies?	yes	yes
DATA ANALYSIS:		
Data analysis was inductive?	no	yes
Findings were consistent with and reflective of data?	yes	yes
Decision trail developed?	yes	yes
Adequate analysis process described?	yes	yes
Meaningful picture of phenomenon under study emerged?	yes	yes
Evidence of credibility?	yes	yes
Evidence of transferability?	no	yes
Evidence of defendability?	yes	yes
Evidence of confirmability?	yes	yes
Conclusions appropriate?	yes	yes
Findings contributed to theory development and future practice/research?	yes	yes

Adapted from: Letts et al. [8].

[17, 19]; 1 study involved 2nd year physiotherapy students [16]; and 1 study involved DPT students in an undefined year in the academic program [13].

Quality review assessment utilising the MERSQI Score yielded a mean score of 9.33 for all quantitative articles with a range of 6–13. Only one of the quantitative studies was a randomised control trial [10], and only 5 of the studies had total MERSQI scores of 10 or greater [9, 11, 12, 14, 15]. All but two [11, 16] of the studies measured participant satisfaction, attitude, perception, opinion, or general facts as opposed to measuring knowledge or skills. Overall, the study design and data analysis for the quantitative studies were appropriate, but most lacked validity of the evaluation instrument used (Table 2). Results of the Critical Review Form: Qualitative Studies (version 2.0) demonstrated overall quality in all 7 assessment criteria, with a few minor exceptions for the two qualitative studies. Sampling methods for both were not done until redundancy, and the study by LaRosa and Dinsmore [20] did not use inductive analysis or show evidence of transferability (Table 3).

Clinical reasoning assessment measures

Within the accepted studies, clinical reasoning was assessed using a variety of measures, including student self-assessment of clinical reasoning, faculty assessment of clinical reasoning performance, and qualitative assessment of clinical reasoning strategies. Eight [9, 10, 12–15, 17, 18] out of 10 of the quantitative studies relied on student self-assessment of perceived clinical reasoning ability, of which three articles [9, 12, 14] utilised the Self-Assessment of Clinical Reflection and Reasoning (SACRR); three articles [10, 13, 17] utilised a researcher-created survey to measure the students' perception of their clinical reasoning ability, one [15] article used the Reasoning for Change (R4C), and one used the SACRR and the Diagnostic Thinking Inventory (DTI) [18]. In two studies, researchers assessed actual clinical reasoning performance. Montpetit-Tourangeau et al. [16], assessed clinical reasoning performance based on faculty evaluation of student problem-solving using a pretest and 2-phase posttest design and Ladyshewsky [11] created an 8 question post-encounter questionnaire to assess students' abilities in the area of diagnosis, management, history and physical exam features. The two qualitative studies [19, 20] assessed strategies used in the process of clinical reasoning. One of the two qualitative studies compared the number of ideas in CR categories [19], while the other used the think aloud methodology with concurrent verbal data collection and counting the number of hypotheses generated [20].

Educational methods

A variety of educational interventions were utilised to teach clinical reasoning with differing outcomes. Activities included theoretical structured case activities, direct patient care activities, simulated patient activities and curriculum design. Participation in these activities involved students working individually, in dyads, or in small groups.

Structured case activities

Six of the studies used structured case activities in a variety of ways [10, 12, 13, 16, 18, 20]. Seif et al. [12] asked students to participate individually in a Moodle Lesson that included viewing a video of a patient interview followed by guided questions, performing a literature search and article reviews, and developing a home exercise program. Authors noted significant changes in 17/26 items on the SACRR with student-perceived improvements in clinical reasoning skills for examination as well as for providing interventions.

In the study by Montpetit-Tourangeau et al. [16], the authors used concept mapping to facilitate clinical reasoning skills. Students were randomly assigned to work individually on electrotherapy cases, followed by either concept map completion (constructing a concept map throughout the guided learning phase) or concept map study (studying a model concept map provided by the faculty throughout the guided learning phase). Immediately after each activity, the students were tested on content and also rated the mental effort that was invested while working through the activity. Results suggest that concept map completion led to better problem-solving performance on posttests and a modest increase in students' confidence in CR skills, suggesting the cognitive processes used by the learners in this option were more effective.

In the study performed by O'Dell et al. [13], a faculty-created Clinical Problem-Solving Educational Forums where clinicians presented actual clinical cases to the students in small group settings. The forums were integrated throughout 5 semesters during the 2nd and 3rd years and the students rotated between 3 clinicians' scenarios. Students discussed the cases in small groups and then were asked individual 'Hot Seat' questions guided by local clinicians to facilitate discussion and to think critically using the patient/client management model. Pre-posttest surveys using a visual analogue scale indicated modest improvements in students' confidence in using critical thinking skills and developing a prognosis and plan of care. A large group student debriefing also indicated that the problem-solving forums were beneficial in improving student confidence in their ability to clinically reason.

Gillardon and Zipp [10], utilised the Hypothesis Oriented Algorithm for Clinicians (HOAC) model to teach clinical decision-making skills using a single case study. HOAC is an organised framework to guide students working in small groups through the clinical decision-making process and a systematic approach to assessing change resulting from an intervention. The authors reported 2 years of data and determined, via a post-activity survey, that students perceived enhanced development of clinical decision-making skills from participation in the activity.

Trommelen et al. [18] used a pretest-posttest design with a double pretest to explore the effects of Case Based Learning (CBL) activities with additional external reflective articulation assignments on CR skills. The assignments required students to complete the Physical Therapy-Clinical Reasoning Tool (3 written assignments). They collected data with the SACRR and the DTI at 3 different time points – initial, before reflection, and after reflection assignments. The students demonstrated significant increases in SACRR & DTI scores between the pre-reflection and the post reflection score, which implies a relationship between the reflection activities and CR skills.

Finally, a study by LaRosa and Dinsmore [20] compared student dyad groups working on a hypothetical musculoskeletal case presented via a written case study or simulated patient experience. Qualitative 'think aloud methodology' was used to assess student clinical judgements when working through the same clinical problem. The results indicated that students using written cases exhibit clinical reasoning skills that more closely resemble the process of expert clinicians by developing more ideas regarding the health condition and contextual factors. However, simulated patient experience

generated significantly more thoughts regarding symptom characteristics, client perspectives, and minimising reasoning errors.

Direct patient care activities

Two articles assessed clinical reasoning using direct patient care activities. Seif et al. [9] evaluated the effects of a semester-long interdisciplinary service learning course and individual participation in a student run clinic (experimental group) compared with a control group of students who either only participated in the clinic or in neither the course nor the clinic (control groups). The activities included live patients with instructor feedback and reflection. Students completed pre and post surveys. Based on the SACRR, students in both the experimental and control groups demonstrated significant changes in perceptions of CR, however, those who participated in the student run clinic had a significantly greater change in their perception of their CR ability.

Willis et al. [14] used two 8-week Problem Based Learning (PBL) courses that involved small group case-based sessions (6 hours/week for 16 weeks) with concurrent direct patient care Integrated Clinical Education (ICE) experience performed in a faculty-supervised student-run free clinic. Students' self-reported CR improvements following the experience and a pre/post survey using SACRR indicated an overall improvement in scores.

Simulated patient care experiences

Simulated patient care experiences were studied by LaRosa and Dinsmore [20], as mentioned above, with the structured case studies as well as in 2 additional articles. Ladyshewsky [11] compared the performance of students working as individuals with students working with reciprocal peer coaching (RPC) on a trained simulated patient case. The results indicated that the RPC group demonstrated higher scores on all measures, including the author-developed post-encounter questionnaire that was used to assess CR when compared to the students working individually. The authors attributed the higher scores to the fact that when working with a peer, there is more opportunity for discussion, feedback, and a more thorough history and exam.

In another study by Ladyshewsky [19] using a simulated patient activity, students worked individually or with a peer coach and were videoed interviewing the patient. The verbal recording was analysed using qualitative methods. Both individuals and groups used similar CR categories but qualitative data analysis indicated students in the peer coaching groups generated more ideas in each CR category, which suggests there may be more free associative cognitive activity, generation of ideas, thoughts and theory. The researchers note the advantages of having students work through clinical assessment in pairs, particularly in the early stages of education.

Curriculum design

Two studies implemented Intentional curriculum design methods to improve CR. Elvén et al. [15] examined the impact of the inclusion of behavioral medicine content and competencies (BMCC) on PT students and investigated CR specific to the client's behavioural change. The results suggest that students with BMCC curricula had superior self-perceived skills in CR on the R4C scale, whereas those without the BMCC had stronger biomedical practice orientation. In addition, students participating in the BMCC curricula scored significantly higher in integrating a biopsychosocial and behavioural approach to CR than those without. For instance, those students had superior self-perceived knowledge, cognitive capabilities and skills in CR, compared with the beliefs of students not receiving BMCC curricula. In the study by Yaqoob et al. [21], the authors assessed using team-based learning on student CR. Students participated in team-based learning (TBL) groups, but the activities used were not clearly identified. However, students agreed that working as a team had a positive influence on their problem-solving and decision-making abilities, which the researchers extrapolated to developing clinical reasoning skills. Table 4 provides an overview of the educational methods utilised within this study.

Discussion

The purpose of this study was to investigate educational methods utilised in physical therapy education programs to promote CR and their impact on developing CR skills and performance. Implications for PT educators can be drawn from these results. First, much variation exists not only in the ways clinical reasoning is taught in physical therapy education programs, but also in the methods in which CR is assessed. Also, students seem to demonstrate improvements in CR skills using a variety of pedagogical methods, suggesting that, in addition to methods of instruction, educators should seek to intentionally differentiate whether the outcome is actual CR competence or student perception of CR performance.

A previous study performed by Huhn et al. [23] described recommendations made by clinical instructors (CIs) to foster CR skills. Recommendations included patient simulations, mentoring programs, more clinical fieldwork, and courses specifically designed to develop CR. Our research has presented studies that have used each of these methods with successful outcomes. Six of the studies in this review used structured case activities in a variety of ways; one used the Hypothesis Oriented Algorithm for Clinicians (HOAC) [10]; one used concept maps [16]; and one used the think aloud methodology to compare student's reasoning process between written case reports and simulated patients [20].

This same study by Huhn et al. [23], also asked CIs about the relevance of self-reflection and found that 88% of 659 participants require students to engage in self-reflection by debriefing with the CI, think aloud during treatments or journal assignments as methods to facilitate CR. Our study also supports these methods with individual students using the think aloud method as well as 8 studies that demonstrated paired or group student activities that were effective at facilitating clinical reasoning [10, 11, 13, 14, 17–20]. Our overall findings imply the value of group and/or dyad activities that foster discussion. Even though all the studies demonstrated improvements in CR, regardless of the type of student participation or outcome measure used, when group activities/discussions were compared to individual activities, students working in dyads or groups were better able to utilise strategies that foster CR and also demonstrated improved perception of development of those skills.

These results are not completely surprising. The Integrated Clinical Education Theory (ICET) is a theoretical framework that was developed to design curricula that fosters CR for nursing students at Vanderbilt University. The ICET emphasises the importance of intentional curriculum design, discourse between students and all team members, reflection, and context of the situation [24]. The value of integration of these constructs in PT education was evident in the results

Table 4. Data extracted from articles investigating educational methods used to teach clinical reasoning in PT education

Study	Sample (*N*)	Description of activity	Type: group/pair/ individual	Duration of activity	Outcome measure	Results
Elvén et al. [15]	Experimental group – 61 Control group – 90	BMCC	Group	Curriculum with BMCC, one semester	Reasoning 4 Change (R4C) instrument Pain Attitudes and Beliefs Scale for Physiotherapists	BMCC experience scored significantly higher in R4C variables relating to clinical reasoning
Gillardon and Zipp [10]	Experimental group – 25 Control group – none	HOAC model Used to teach clinical decision-making skills with a case study	Groups of 3–6 students	One-time activity	4-question, student survey – students rated activity on a 1–5 Likert Scale	Students rated activity as beneficial towards improving CR Avg. Likert scale scores ranged 3.5–4.0 on a 5 pt scale
Ladyshewsky [11]	Experimental group – 62 Control group – none	Simulated patient training	Groups/pairs – RPC, 21 pairs (n = 42) – Individual students (n = 20)	One time, length not specified	Post Encounter Questionnaire (PEQ) – designed to evaluate clinical reasoning	RPC group obtained statistically significant higher scores for the overall test and the management section, indicating improved clinical reasoning
Ladyshewsky [19]	Experimental group – 12 – 6 worked independently – 6 worked with peer coach Control group – none	Evaluated a simulated patient Support for peer discussion 'Talk aloud' videotaped, which was analysed qualitatively	Individual and pair	One-time simulated patient interview	Qualitative analysis of transcript data Examined qualitative data by 'Counts' – measuring the frequency of each participant's verbalisations within each CR category	Peer coaching group generated more ideas in each CR category – suggests there may be more free associative cognitive activity, generation of ideas, thoughts and theory
LaRosa et al. [20]	Experimental group – 14 Control group – none	Students clinically reason through a hypothetical case study	Pairs/groups – 1 group (3 pairs) worked on a simulated case – 1 group (4 pairs) worked on a written case	30-minute duration	Think aloud methodology via concurrent verbal reports Iterative process of data analysis Quantitative analysis of the frequency of hypothesis generation for each group	Simulated patient group generated significantly more client perspectives and minimised reasoning errors
Montpetit-Tourangeau et al. [16]	Experimental group – 61 – 31 – concept map completion (N = 16 novice learners, N = 15 advanced learners) – 30 – concept map study condition (N = 16 novice learners, N = 14 advanced learners) Control group – none	Worked with examples on electrotherapy cases followed by either concept map completion or concept map study	Individual	Three phases: – Pretest phase – 130-minute guided learning phase – Four-week self-study phase	Directly after each activity, participants completed a monitored posttest and rated the mental effort they invested while working through the activity	Concept map completion fostered more meaningful learning of PT intervention knowledge in both near and far transfer study and led to better problem-solving performance on posttests
O'Dell et al. [13]	Experimental group – 23 Control group – none	Clinical Problem-Solving Educational Forums	Group	3–30-minute rotational sessions	Pretest and posttest survey – Visual analogue scale consisting of 9 statements with disagree & agree anchors	Modest improvement in students' confidence in using critical thinking skills and developing a prognosis including a plan of care
Seif et al. [16]	Experimental group – 63 Control group – none	Case study involving Moodle platform; consisting of a video patient interview, followed by a series of guided questions	Individual	One-time, 1–4-hour lesson	SACRR Pre/post survey to assess students' perceptions of teaching methods	Improvement in perceptions of clinical reasoning Students perceived improvements in clinical reasoning skills for examination and providing intervention

Seif et al. [9]	Experimental group – 100 Control group – 232	Service learning course, including live patients with instructor feedback on clinical decision-making process	Group	Four times during semester	Interdisciplinary Education Perception Scale (IEPS) Readiness for Interprofessional Learning Scale (RILS) SACRR	Experimental group demonstrated improvement in perceptions of clinical reasoning skills
Trommelen et al. [18]	Experimental group – 27 Control group – none	Reflection on CBL	Group	2×/week for a semester	SACRR DTI	Significant increases in SACRR & DTI scores between the pre-reflection and the post reflection score
Willis et al. [14]	Experimental group – 42 Control group – none	Integrated Clinical Experience (ICE) and Problem Based Learning (PBL)	Individual	2–8-week PBL courses (6 hours/week for 16 weeks) with concurrent ICE	SACRR	Self-reported CR improved Overall SACRR score improved
Yaqoob et al. [21]	Experimental group – 222 Control group – none	TBL	Group	3-month duration of TBL	Minnesota Satisfaction Questionnaire – 5-point Likert scale	TBL had a positive effect on improving decision-making involved with CR

BMCC – Behavioural medicine content and competencies, HOAC – Hypothesis Oriented Algorithm for Clinicians, CR – clinical reasoning, RPC – reciprocal peer coaching, SACRR – Self-Assessment of Clinical Reflection and Reasoning, DTI – Diagnostic Thinking Inventory, CBL – Reflection on Case-Based Learning, TBL – team-based learning

of our review, as well. For instance, the studies by Seif et al. [9] and Willis et al. [14] integrated intentional curricular design to include reflection and dialogue between students and instructors and peers. The results from Gillardon and Zipp [10], LaRosa and Dinsmore [20], Trommelen et al. [18], and Montpetit-Tourangeau [16] also demonstrated the value of group work and/or reflection. The results of the study by Willis et al. [14] specifically identified positive outcomes from ICE combined with PBL activities. Integrated Clinical Education is also supported by the APTA. In a 2017 statement from ACAPT, 'Integrated clinical education is a curriculum design model whereby clinical education experiences are purposely organized within a curriculum. In physical therapist education, these experiences are obtained through the exploration of authentic physical therapist roles, responsibilities and values that occur prior to the terminal full-time clinical education experience' [25]. Similarly, research in occupational therapy has demonstrated that critical thinking and CR development in OT students is dependent on student reflection and experience with a variety of patient and environmental situations [26].

As noted in this review, there was clearly as much variation in the assessment used to measure clinical reasoning as there were methods used to teach it. The results of a scoping review on clinical reasoning assessment indicated that many of the studies lacked clarity in the description of the methods used and lacked validated assessment approaches to measure CR [27]. The authors also recommended that future research explicitly define the construct of CR, integrate support from a theoretical framework, and provide adequate detail and evidence for the validity of the assessment tool used. In our review, 9 [9–15, 17, 18] of the 10 quantitative studies relied on student self-assessment to assess clinical reasoning with only the study by Montpetit-Tourangeau et al. [16] utilising faculty evaluation of problem-solving performance. Four of those 9 [9, 10, 12, 14], used the SACRR; one used the SACRR and the DTI; two studies [13, 17] used student perception based on 1 survey question that looked at the impact on CR ability; one [15] used the R4C; and one used an author-created post-event questionnaire [11]. The two qualitative studies [19, 120] used different methods as well. Ladyshewsky [19] compared the number of ideas in CR categories, and LaRosa and Dinsmore [20] used the think aloud methodology with concurrent verbal data collection, along with the number of hypotheses generated. This variation in CR assessment made it difficult to objectively and equitably compare outcomes among studies.

Limitations

Limitations to this systematic review included study variations, such as inconsistent methodology, small sample size, lack of a control group, lack of control of external variables, inconsistent measures of CR, and the lack of a description of the constructs measured and methods used. In general, learning effects from concurrent classes may also have contributed to the improvements seen in many of the studies. Another limitation was the range of rigour of the studies, as assessed by the MERSQI and the Critical Review Form: Qualitative Studies (version 2.0), particularly related to the validity of the tools used and objectivity of the outcomes measured, which may limit the transferability of the results of each individually. However, due to the limited number of eligible studies, the researchers decided not to omit studies based on those characteristics, because there was descriptive value in the data extracted about the instructional methods and assessment measures used.

Future recommendations

Clinical reasoning is an important skill for PTs to develop. The inconsistencies in teaching and assessing make it difficult for new faculty and clinicians to implement appropriate methods and select reliable outcome measures. If there was better evidence to support or refute certain techniques, PTs in academia or in the clinic could be more explicit about the expectations of the student, which could potentially help to prepare more efficient clinicians. Future high-quality research is needed to clearly describe the methods used to define, develop, and assess CR and should investigate the reliability and validity of tools like the PT-CRT, the SACRR, the R4C, and the DTI as well as the correlation between scores on these tools and outcome measures such as clinical performance and NPTE scores. Furthermore, although there is increasing discussion and research regarding CR in the education of physical therapists, only one study was identified regarding CR in physical therapist assistant education [28]. This study not only suggested that CR is an important skill for PTAs to develop, but also identified the constructs of the ICET as applicable to the development of CR in PTA students. The purpose of CR may be different in PTA performance/activities, but the value of CR to PTAs should not be diminished and would be worthy of future research.

Conclusion

The results of this systematic review indicate that there is a wide variety of pedagogical methods being utilised within PT education to promote CR skills, including simulated patients, structured case activities, direct patient care activities, and curriculum design modifications. Regardless of the instructional methods used, all improved CR skills, but those that included dyad or group work were more effective than those that included only individual work. There is also a variety of outcome measures used to assess CR, but the majority are based on student self-assessment. This variation and lack of objectivity make it difficult to compare methods or outcome measures. Further research that explores the development and assessment of CR skills will benefit PT educators, students, practitioners, and, ultimately, patients.

Disclosure statement

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Conflict of interest

The authors state no conflict of interest.

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