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Student Physical Therapists' Perceptions of Clinical Reasoning: A Systematic Review of the Literature

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Abstract

Introduction: Clinical reasoning (CR) is a core clinical skill that has been directly linked with patient outcomes. Therefore, developing sound clinical reasoning skills in students should be a concern for physical therapy (PT) professional education programs.

Purpose: To develop an understanding of PT student perceptions of CR and how they best learn it to inform future educational practice and research needs.

Method: A systematic review of the literature was conducted using the databases PubMed, CINAHL, ERIC, and Cochrane database of systematic reviews to develop an understanding of how students perceive CR throughout their professional education programs and how they best learn it.

Results: Fifteen articles met inclusion criteria. Three major themes were identified from the systematic review. First, student perceptions of CR do change throughout their professional education programs. Second, students prefer educational experiences that allow them to act in a PT role, for instance case-method teaching. Lastly, that educational experiences designed to enhance CR capability enhances student professional formation and identity.

Discussion: Recent calls for reform across all levels of physical therapy education has been made. In part, these reform efforts emphasize the need for PT education programs to provide learner-centered education through practice-based learning experiences and developing adaptive learners. The results of the systematic review support these aims. More research is needed regarding the impact of educational experiences on student CR skill development as well as more valid and reliable tools for assessing CR capability in PT students.

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1. Introduction

1.1. Clinical reasoning (CR)

Clinical reasoning (CR) is considered a foundational skill of health profession clinical practice that informs decision-making about patient and client problems.¹ CR capability has been described as the ability to implement and synthesize key learning and thinking skills in clinical practice and is typically exemplified in experts but often absent or underdeveloped in student novices.² For example, *reflective thinking* has been said to allow clinicians to make sense of complex clinical situations, and facilitate learning of new reasoning strategies for dealing with similar cases in the future. Specific to the PT profession, CR has been conceptualized as the integration of cognitive, psychomotor, and affective skills.³ These skills are requisite for students to learn in order to make sound clinical decisions considerate of the unique needs of their individual patient's.⁴

Given the importance of CR in both the progression of students' learning in professional education programs and the need to provide quality patient care during clinical education experiences, PT educators and researchers need to better understand both what CR is and how PT students best learn it. One issue with facilitating CR skill development is that it is a highly-contextualized concept that no single model can fully explain.^{1,5} For instance, CR in fast-paced and complex acute care settings has been conceptualized in part as performing exhaustive chart reviews to obtain and evaluate pertinent medical factors that may preclude patients from participating in a physical therapy program,⁶ while CR in pediatric physical therapy requires enhanced consideration of the child's developmental level and participation in age appropriate activities.⁷ Research in reasoning has mostly focused on what constitutes expertise in CR, how to develop it, and how to assess it.^{4,8,9} However, more attention needs to be paid in how students perceive the CR process in their professional education programs and their perceptions about which instructional methods best facilitate desired CR capabilities such as *reflective thinking*, *critical thinking*, *dialectical thinking*, and *complexity thinking*.¹⁰

1.2. Theoretical background

Developing CR capability is a big concern of educators in professional education programs. One reason for this is due to the acceptance that the PT body of literature is inadequate for informing the wide range of clinical decisions PTs make with their patient's.¹¹ This

concern has led to a plethora of research regarding instructional methods for facilitating desired CR skills in students.^{12–15} However, a recent call for reform in physical therapy education has identified an increased need for providing *learner-centered* education.¹⁶ Learner-centered education occurs when “attention is focused on the learner and the actual and possible learning that might occur.”¹⁶ When implementing learner-centered education it is the educator's responsibility to ensure the learning task is matched with their student's ability. For instance, it has been suggested that excessive cognitive load resulting from learning concepts that are inherently difficult (intrinsic load), the way the information is presented (extraneous load), and too much new information at once (germane load) can be detrimental to student learning.¹⁷ Therefore, a requisite to providing learner-centered education is an understanding of students' current level of CR capability to ensure educational experiences are best matched to their learning needs.

Additionally, Jensen et al. (2019) have suggested one goal of professional education programs should be to develop adaptive learners. Adaptive learners are individuals capable of recognizing situations that require innovative methods to accomplish task goals and have developed skills for transforming the way they practice.^{16,18} These skills assist adaptive learners thrive in situations of higher complexity and uncertainty. When developing adaptive learners, Schumacher et al.¹⁷ suggested students need to take on more responsibility for their learning. However, when providing learner-centered instruction, educators must be careful not to relinquish all responsibility of learning to their students. Therefore, education should be regarded as a shared responsibility among students and educators learning from each another enhancing clinical and educational practices.¹⁹

It's important to note when providing learner-centered education, Jensen et al.¹⁶ have made clear that educators should not focus their instructional methods to provide what students perceive they need or want. It is ultimately the educator's responsibility to ensure that the instructional methods they implement align with contemporary best practice standards for facilitating those clinical reasoning capabilities required to succeed in clinical practice. Thus, they have recommended increased implementation of practice-based learning across professional and post-professional education programs.

Practice-based learning is learning through experience. Students benefit when the learning they create is situated in experiences that match the conditions under

which they are expected to practice. When providing practice-based learning experiences, educators need to ensure that the complexity of clinical problems are matched to their student's ability while ensuring the safety of the student and "patient". Along the way educators and students develop meaningful reciprocal relationships that fosters learning in both educator and student.

Literature in psychology indicates that an understanding of what a phenomenon is and how it is perceived are both important.^{20,21} In doing so, educators can create more meaningful educational experiences for their students that bridge their current perception and understanding of CR to a more contemporary and accepted understanding of what CR really is. Therefore, PT educators wanting to provide learner-centered education and produce adaptive learners must become attuned to their student's current level of ability and willingness to take on responsibility for their learning. An understanding of student perceptions regarding CR in physical therapy professional education may inform PT educators when and how to implement practice-based learning experiences that facilitate adaptive learning skills in PT students.

1.3. Purpose

The purpose of this study was to conduct a systematic review of the literature regarding PT student perceptions of CR. The systematic review was framed by the following research questions:

- (a) How do PT students perceive clinical reasoning for the physical therapy profession during their professional education programs?
- (b) How do PT students perceive they best learn clinical reasoning skills in professional education programs?

2. Methods

2.1. Search strategy

A recent systematic review of the literature was conducted to address the research questions. The databases PubMed, CINAHL, ERIC, and Cochrane Database of Systematic Reviews were selected to provide a robust review of the literature while ensuring similar reviews have not been conducted recently. It was identified that the terms CR, clinical-decision making, and critical thinking are often used interchangeably in the literature.^{22,23} In consideration of

these terms, MeSH headings were used to ensure that retrieved articles had at least one of these terms as a major topic. Therefore, the final PubMed search took on the following form: "Physical Therapy Specialty" [Majr] AND (("Clinical Decision-Making" [Majr]) OR ("Thinking" [Majr]) OR "clinical reasoning"). Similarly, the CINAHL database was searched with the same key terms and major headings as the PubMed search. However, the CINAHL database divides the term physical therapy by several major headings. To limit extraneous returns from the literature search, the major headings "Students, Physical Therapy" and "Education, Physical Therapy" were selected for their relevance. Therefore, the final CINAHL search took on the following form ((MM "Students, Physical Therapy") OR (MM "Education, Physical Therapy")) AND (("clinical reasoning") OR (MM "Decision Making, Clinical") OR (MM "Critical Thinking")). Similar search terms were entered to locate literature in the ERIC and Cochrane databases.

2.2. Inclusion and exclusion criteria

The following criteria was imposed for determining eligibility for inclusion in the final review. First, the article had to provide empirical evidence through quantitative, qualitative or mixed-methods for student perceptions of CR. Additionally, only articles whose full-text could be obtained in English were considered for eligibility. Commentaries, editorials, abstracts, and posters were excluded. Furthermore, articles printed before 2000 were excluded because the authors wanted to discover more contemporary student perceptions of CR. We chose to rely solely on peer-reviewed works for this review to better ensure the quality of the data and conclusions being synthesized. It should be noted this excluded "gray literature" which could contain relevant data and conclusions to the questions pertinent to this examination. While meta-analyses are particularly vulnerable to issues of peer-review,²⁴ this systematic review is more centered on a synthesis of high-quality data to make instructional decisions in PT, rather than trying to evaluate the scope of quality within the literature on CR in PT.

From the eligible articles under consideration for inclusion, a total of 15 were reviewed by two raters. Percentage agreement among the raters was 85% and resulted in a Cohen kappa value of .70 indicating substantial inter-rater reliability.²⁵ Differences in opinion were rectified among the raters via phone conference. All remaining articles were included or excluded by the primary author.

2.3. Evaluation and theme development

After obtaining the final sample for the systematic review, all articles were evaluated and placed into initial groupings by similarities regarding student perceptions that were reported. An iterative process was undertaken to identify major themes from these groupings. After identifying major themes, articles were re-evaluated for potential cross-theme matching. This process continued until a saturation effect was reached that all articles were appropriately matched to the identified themes.

3. Results

A total of 445 records were retrieved from the database searches. After removing duplicates and imposing the inclusion/exclusion criteria, a total of 15 articles were included in the final review (Fig. 1). After reviewing the literature, we identified three major themes from the systematic review. The first theme was student perceptions of CR for the physical therapy profession within their professional education programs. The second theme was student perceptions of educational experiences that facilitated their CR skill development. The last theme was the perception of CR educational experiences on their professional development and identity. The following sections will present the findings from the systematic review for each theme followed by a discussion of the significance of these findings and implications for future educational practice and research.

3.1. Student perception of CR in professional education

The first theme detailed how students perceived CR in the physical therapy profession directly answering our first research question (Table 1).^{14,23,26,27} All four of these studies identified that students considered CR as a therapist-centric process at some point in their professional education. Two of these studies presented longitudinal findings. First, Furze et al.²³ outlined three tiers of CR development students go through during their professional education. For instance, students early on in their professional education exhibited more compartmentalized thinking with little flexibility in thought and action when performing physical examination procedures to developing an appreciation for narrative reasoning and reflection-in-action to adjust physical examination procedures that met the individual needs of their patients. Similarly, Hendrick et al.²⁷

identified five conceptualizations students have when they progress through their respective programs. They found that students in their last two years of a four-year professional education program were the only ones to conceptualize CR as a problem-solving process inclusive of metacognitive skills such as reflection-in-action and reflection-on-action.

3.2. Perceptions of CR education experiences

The second theme was how students perceived they best learned CR in their professional education programs directly answering the second research question (Table 1).^{13,28–37} Of these studies four of them found students believed case-method teaching positively influenced their CR skill development.^{28,29,31,32} For instance, Maas et al.³² implemented case-method teaching presented via simulated patient and found that students perceived acting in the therapist role enhanced their learning more than acting in the role of the client. Additionally, they found that students preferred case-method instruction more than group projects or algorithms and flowsheets in their musculoskeletal courses.²⁸ Additionally, two studies described student perceptions of educational experiences designed to develop specific CR skills such as narrative reasoning and reflection.^{13,34} Both studies found that students believed these educational experiences positively contributed to their learning. The effect of technology on student perceptions regarding their learning preferences and professional development has been investigated.^{35,37} For instance, Snodgrass³⁵ discovered that students perceived technology-based instruction as less valuable than in-class sessions for their learning. However, Rowe et al.³⁷ found that integrating Google Drive in the classroom assisted in changing students' perceptions of learning from a teacher driven process to a self-driven one.

3.3. Professional development and identity formation

The final theme was student perceptions of instructional methods contributing to the growth of their professional development and identity formation (Table 1).^{14,37} For example, students believed the addition of Google Drive to an "Applied Physiotherapy" module assisted in transforming their perceptions of learning from being simple remote memorization to the recognition of the importance of acquiring those traits and skills necessary to become a life-long learner.³⁷ Additionally, Cruz et al.¹⁴ found that a specific reasoning course altered student

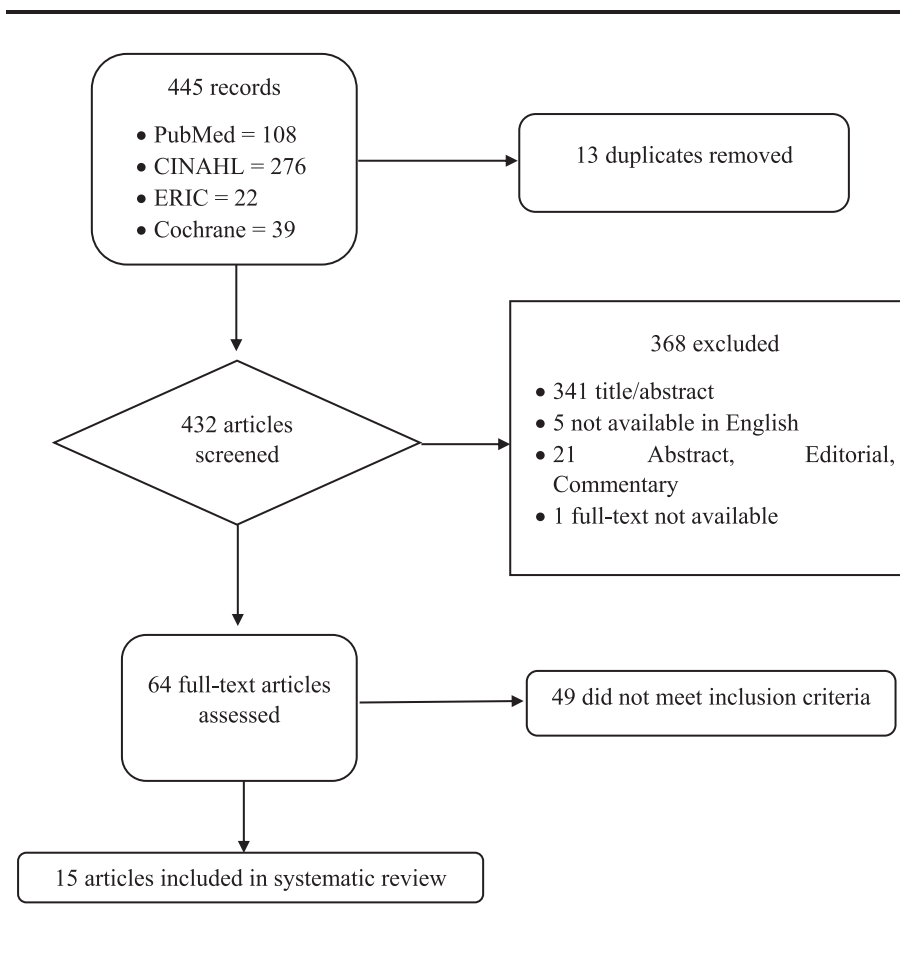


Fig. 1. PRISMA flow chart of systematic review process.

perceptions from physical therapy as a therapist-centric profession to one that is patient-focused. This is interesting because the importance of a collaborative approach to patient management in PT practice has previously been established.^{38,39} Furthermore, Huhn et al.³ stated effective collaborative reasoning requires the integration of cognitive, psychomotor, and affective reasoning skills for making sound clinical decisions. This finding from Cruz et al.¹⁴ highlights how a specific CR course can affect the approach novice clinicians take with their patients and enhances our understanding of the first research question.

4. Discussion

The systematic review identified a total of 15 studies detailing student perceptions of CR in professional education. Regarding instructional methods,

case-method teaching was most reported in this literature review.^{29–33} These studies indicated that students generally regarded case-method teaching as beneficial to their learning. Furthermore, it was found that students perceived educational opportunities that allow them to act in a therapist role better facilitated their learning than peer or expert feedback did.³² This is interesting because it suggests students perceive their own reflection-in-action and reflection-on-action as higher contributors to their learning than feedback from more experienced educators, and highlights the importance of developing sound metacognition skills, such as reflection, when preparing students to function in the clinical environment. In fact, a recent survey of PT educational programs found that 91% of these programs incorporate self-reflection skill development in their curricula.²² However, the same survey also found 45% of these programs do not use a standardized

Table 1
Student perceptions of clinical reasoning.

Theme 1. Perceptions of Reasoning in Professional Education	
Citation	Student Perception
Cruz et al. ¹⁴	Reasoning perception changed from a therapist-centric view to an increase focus on the patient
Furze et al. ²³	Reasoning initially perceived as cognitively rigid with minimal consideration for individualized patient circumstances progressing to patient focused reasoning with flexibility in patient examination
Cruz et al. ²⁶	Reasoning perceived as an instrumental process, clinician-centered, and dependent on clinician knowledge and clinical context
Hendrick et al. ²⁷	Five conceptualizations of reasoning identified; ranging from application of rote knowledge to a problem-solving and pattern building process inclusive of meta-cognition
Theme 2. Perceptions of Education Experiences	
Citation	Student Perception
Caeiro et al. ¹³	Inclusion of arts, literature, and reflective writing in a narrative reasoning course perceived as beneficial for facilitating empathy for patient circumstances, enhanced understanding of self in the delivery of PT services, and importance of reflection in the reasoning process
Miller et al. ³³	Patient examination module prior to clinical education experiences perceived as beneficial for enhancing confidence before beginning the clinical education component of their curriculum, and organizing their clinical examinations when working with patients
Maas et al. ³²	Performing in the therapist role perceived as most valuable during simulated physical therapy practice experiences
Boucher et al. ³⁶	Flipped classroom model for musculoskeletal curriculum perceived as useful and effective allowing for more in-depth discussion, and inclusion of simulated patient experiences
Rowe et al. ³⁷	Use of Google Drive altered perceptions of learning from teacher-driven to self-driven
Loghmani et al. ³¹	Integrated Longitudinal Case-Based Learning perceived as beneficial for facilitating critical thinking and problem-solving skills, and clinical decision-making ability
Snodgrass ³⁵	Web-based wikis perceived as more valuable than in-class sessions for learning
Babyar et al. ²⁸	Demonstration with students and actual patients perceived as positive for learning
Roche and Coote ³⁴	Addition of reflection module promoted client-centered practice, and integration of evidence into the practice setting
Babyar et al. ²⁹	Students preferred live demonstrations with actual clients and case-method teaching for learning
Gillardon and Zipp ³⁰	Case-method teaching regarded positively for facilitating hypothetico-deductive reasoning skills, and overall learning
Theme 3. Professional Development and Identity Formation	
Citation	Student Perception
Cruz et al. ¹⁴	Perceived themselves differently as clinicians which challenged the way they interacted with patients
Rowe et al. ³⁷	Identity formation and understanding of needing to develop skills to become a life-long learner

method for assessing reflection development in students and of the programs that do assess reflection development, most use a wide variety of assessment tools limiting the ability to compare reflection skill acquisition across programs.

A recent call for educational reform has emphasized that excellence in professional education should be centered on providing experiences that are learner- and patient-centered.^{40,41} Additionally, they emphasized the need for earlier and more frequent exposure to practice-based learning experiences. The systematic review identified that students perceived their learning

is accelerated when they are actively engaged in experiences that mimic the clinical environment.^{32,33}

This highlights the continued need to shift educational pedagogy from the teacher as a purveyor of knowledge to a collaborative learner-centered one.

Regarding studies that investigated student perceptions of CR in physical therapy, everyone identified that students perceived CR as a therapist-centric process at some point in their professional education. Interestingly, studies providing longitudinal findings^{23,27} found PT students are capable of perceiving CR as a problem-solving process often requiring

adjustments to examination procedures as new clinical data emerges. This requires fluidity in cognition and psychomotor behavior; skills typically associated with expert reasoning.⁴ However, Hendrick et al.²⁷ also found that a significant portion (80%) of fourth-year students did not perceive CR as a problem-solving process. In fact, they found that an equal number of fourth-year students ($n = 2$) conceptualized CR as a trial-and-error process, the lowest level of CR conceptualization identified in their study, as did students who did conceptualized CR as a problem-solving process. This largely speaks towards the wide range of learning that occurs among students from the same PT education programs and emphasizes a need to consider the creation and implementation of reliable and valid standardized assessments for core CR skills such as critical thinking, reflective thinking, complexity thinking, and dialectical thinking.² In addition to increased exposure to practice-based learning experiences, it has been recommended that educational experiences are implemented for developing adaptive learners.^{40,41} Adaptive learners understand learning and expertise development as a life-long endeavor and efficiently apply their knowledge and skills under conditions of ambiguity.¹⁶ Educators must consider creating safe educational experiences that challenges their students to think *outside the box* when confronted with more complex and challenging tasks. These experiences need to be carefully constructed for each individual student to ensure they are being appropriately challenged.

Regarding educational experiences, the findings from the systematic review identified students perceived case-method teaching as valuable to their learning of CR skills. Case-method teaching incorporates the use of clinical vignettes or even full cases, often constructed from real-life experiences to facilitate problem-solving skills.⁴² One advantage of case-method teaching is the multitude of ways cases can be constructed and presented to students.⁴³ For instance, written case reports offer the advantages of being relatively cheap to construct and readily available in the literature.¹⁵ On the other hand simulated patient experiences use actors to portray a clinical case. Simulated patient experiences have the advantages of allowing students to practice varied clinical skills such as performing physical examination tests, and conducting patient interviews.¹⁵ The use of case-method teaching in PT education programs may compliment community practice-based learning experiences for developing CR skills in PT students.

Lastly, two studies outlined how instructional strategies impacted student perceptions of their professional development.^{14,37} For example, students believed a stand-alone narrative reasoning course changed their beliefs of physical therapy as a clinician-centered profession to one that is collaborative, and inclusive of the client's narrative voice which contributed to students ultimately self-identifying as client-centered practitioners.¹⁴ This answers another call for educational reform by enhancing student professional formation through an understanding of the moral obligations they have to their client's and the society they serve.⁴⁰

4.1. Limitations

This systematic review enhances our understanding of student perceptions of CR in PT and how they perceive they best learn this type of reasoning. However, the perception of a phenomenon does not always align with actual events in the classroom. However, by facilitating these perceptions, it is more likely that students can take advantage of activities designed to foster CR in the classroom. Although we believe an understanding of student perceptions assists the educator in creating more individualized and meaningful learning experiences, this may not always be enough. It is also necessary to track how these perceptions mirror or influence actual events in the classroom, a ripe area for future research.

Additionally, the exclusion of gray literature was another possible limitation. As stated previously, our intent was to synthesize high-level empirical based studies informing student perceptions of CR. While the exclusion of gray literature increases the quality of the articles in the synthesis, it is also possible this may have excluded relevant findings to our investigation.

5. Conclusion

The purpose of our systematic review was to identify student perceptions regarding CR for the physical therapy profession and how they feel they best learn reasoning skills. This review was meant to inform educators of CR in recent calls for educational reform across physical therapy education and provide an understanding for how student perceptions may influence how learner-centered education may be provided moving forward. We also found that student perceptions of what constitutes the CR process in professional education varies widely even in those close to graduation. Future research should investigate the effects of

early and frequent practice-based learning experiences and their impact on developing advanced CR conceptualizations and practice behaviors.

References

- Higgs J, Jensen GM. Clinical reasoning: challenges of interpretation and practice in the 21st century. In: Higgs J, Jensen GM, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 4th ed. Edinburgh: Elsevier; 2019:3–11.
- Christensen N, Jensen GM. Developing clinical reasoning capability. In: Higgs J, Jensen GM, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 4th ed. Edinburgh: Elsevier; 2019:427–433.
- Huhn K, Gilliland SJ, Black LL, Wainwright SF, Christensen N. Clinical reasoning in physical therapy: a concept analysis. *Phys Ther*. 2019;99(4):440–456. <https://doi.org/10.1093/ptj/pzy148>.
- Boshuizen HPA, Schmidt HG. The development of clinical reasoning expertise. In: Higgs J, Jensen GM, Loftus JS, Christensen N, eds. *Clinical reasoning in the health professions*. 4th ed. Edinburgh: Elsevier; 2019:57–65.
- Higgs J, Jones MA. Clinical decision making and multiple problem spaces. In: Higgs J, Jones MA, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 3rd ed. Amsterdam: Elsevier; 2008:3–17.
- Masley PM, Havrilko C-L, Mahnensmith MR, Aubert M, Jette DU, Coffin-Zadai C. Physical therapist practice in the acute care setting: a qualitative study. *Phys Ther*. 2011;91(6):906–922. <https://doi.org/10.2522/ptj.20100296>.
- Kenyon LK. The hypothesis-oriented pediatric focused algorithm: a framework for clinical reasoning in pediatric physical therapist practice. *Phys Ther*. 2013;93(3):412–421. <https://doi.org/10.2522/ptj.20120080>.
- Jensen GM, Resnik LJ, Haddad AM. Expertise and clinical reasoning. In: Higgs J, Jensen GM, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 4th ed. Edinburgh: Elsevier; 2019:57–65.
- Macauley K, Brudvig TJ, Kadakia M, Bonneville M. Systematic review of assessments that evaluate clinical decision making, clinical reasoning, and critical thinking changes after simulation participation. *J Phys Ther Educ*. 2017;31(4):64–75. <https://doi.org/10.1097/JTE.0000000000000011>.
- Christensen N, Jones MA, Higgs J, Edwards I. Dimensions of clinical reasoning capability. In: Higgs J, Jones MA, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 3rd ed. Amsterdam: Elsevier; 2008:101–110.
- Jones MA, Edwards I, Jensen GM. Clinical reasoning in physiotherapy. In: Higgs J, Jensen GM, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 4th ed. Edinburgh: Elsevier; 2019:247–260.
- Huhn K. Effectiveness of a clinical reasoning course on willingness to think critically and skills of self-reflection. *J Phys Ther Educ*. 2017;31(4):59–63. <https://doi.org/10.1097/JTE.0000000000000007>.
- Caeiro C, Cruz EB, Pereira CM. Arts, literature and reflective writing as educational strategies to promote narrative reasoning capabilities among physiotherapy students. *Physiother Theory Pract*. 2014;30(8):572–580. <https://doi.org/10.3109/09593985.2014.928919>.
- Cruz EB, Caeiro C, Pereira C. A narrative reasoning course to promote patient-centred practice in a physiotherapy undergraduate programme: a qualitative study of final year students. *Physiother Theory Pract*. 2014;30(4):254–260. <https://doi.org/10.3109/09593985.2013.863415>.
- Rivett DA, Jones MA. Using case reports to teach clinical reasoning. In: Higgs J, Jones MA, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 3rd ed. Amsterdam: Elsevier; 2008:477–484.
- Jensen GM, Mostrom E, Hack LM, Nordstrom T, Gwyer J. *Educating physical therapists*. Thorofare, NJ: Slack Incorporated; 2019.
- Schumacher DJ, Englander R, Carraccio C. Developing the master learner: applying learning theory to the learner, the teacher, and the learning environment. *Acad Med*. 2013;88(11):1635–1645. <https://doi.org/10.1097/ACM.0b013e3182a6e8f8>.
- Cutrer WB, Miller B, Pusic MV, Mejicano G, Mangrulkar RS, Gruppen LD, et al. Fostering the development of master adaptive learners: a conceptual model to guide skill acquisition in medical education. *Acad Med*. 2017;92(1):70–75. <https://doi.org/10.1097/ACM.0000000000001323>.
- Weimer M. *Learner-centered teaching : five key changes to practice*. 2nd ed. San Francisco: Jossey-Bass; 2013.
- James W. *The principles of psychology*. vol. 1. London: Macmillan; 1890.
- Anderson JR. *Cognitive psychology and its implications*. 6th ed. New York, NY: Worth Publishers; 2005.
- Christensen N, Black L, Furze J, Huhn K, Vendrely A, Wainwright S. Clinical reasoning: survey of teaching methods, integration, and assessment in entry-level physical therapist academic education. *Phys Ther*. 2017;97(2):175–186.
- Furze J, Black L, Hoffman J, Barr JB, Cochran TM, Jensen GM. Exploration of students' clinical reasoning development in professional physical therapy education. *J Phys Ther Educ*. 2015;29(3):22–33.
- Schmucker C, Bluemle A, Briel M, Portalupi S, Lang B, Motschall E, et al. A protocol for a systematic review on the impact of unpublished studies and studies published in the gray literature in meta-analyses. *Syst Rev*. 2013;2:24. <https://doi.org/10.1186/2046-4053-2-24>.
- Fleiss JL. Measuring nominal scale agreement among many raters. *Psychol Bull*. 1971;76(5):378–382.
- Cruz EB, Moore AP, Cross V. A qualitative study of physiotherapy final year undergraduate students' perceptions of clinical reasoning. *Man Ther*. 2012;17:549–553. <https://doi.org/10.1016/j.math.2012.05.013>.
- Hendrick P, Bond C, Duncan E, Hale L. Clinical reasoning in musculoskeletal practice: students' conceptualizations. *Phys Ther*. 2009;89(5):430–442. <https://doi.org/10.2522/ptj.20080150>.
- Babyar SR, Pivko S, Rosen E. Pedagogical tools to develop clinical reasoning: physical therapy students' perspective. *J Allied Health*. 2010;39(3):e97–e104.
- Babyar SR, Rosen E, Sliwinski MM, Krasilovsky G, Holland T, Lipovac M. Physical therapy students' self reports of development of clinical reasoning: a preliminary study. *J Allied Health*. 2003;32(4):227–239.
- Gillard P, Zipp GP. A proposed strategy to facilitate clinical decision making in physical therapist students. *J Phys Ther Educ*. 2002;16(2):57–63.
- Loghmani MT, Bayliss AJ, Strunk V, Altenburger P. An integrative, longitudinal case-based learning model as a curriculum strategy to enhance teaching and learning. *J Phys Ther Educ*. 2011;25(2):42–50.

32. Maas MJM, Sluijsmans DMA, van der Wees PJ, Heerkens YF, Nijhuis-van der Sanden MWG, van der Vleuten CPM. Why peer assessment helps to improve clinical performance in undergraduate physical therapy education: a mixed methods design. *BMC Med Educ.* 2014;14. <https://doi.org/10.1186/1472-6920-14-117>, 117–117.
33. Miller AH, Tomlinson S, Tomlinson JD, Readinger J. Addition of a patient examination module to address student preparedness for the first full-time clinical experience. *J Phys Ther Educ.* 2017;31(2):30–43. <https://doi.org/10.1097/00001416-201731020-00005>.
34. Roche A, Coote S. Focus group study of student physiotherapists' perceptions of reflection. *Med Educ.* 2008;42(11):1064–1070.
35. Snodgrass S. Wiki activities in blended learning for health professional students: enhancing critical thinking and clinical reasoning skills. *Australas J Educ Technol.* 2011;27(4):563–580.
36. Boucher B, Robertson E, Wainner R, Sanders B. Flipping' Texas state university's physical therapist musculoskeletal curriculum: implementation of a hybrid learning model. *J Phys Ther Educ.* 2013;27(3):72–77.
37. Rowe M, Bozalek V, Frantz J. Using Google drive to facilitate a blended approach to authentic learning. *Br J Educ Technol.* 2013;44(4):594–606. <https://doi.org/10.1111/bjet.12063>.
38. Edwards I, Jones M, Higgs J, Trede F, Jensen G. What is collaborative reasoning? *Adv Physiother.* 2004;6(2):70–83. <https://doi.org/10.1080/14038190410018938>.
39. Trede F, Higgs J. Collaborative decision making. In: Higgs J, Jones MA, Loftus S, Christensen N, eds. *Clinical reasoning in the health professions*. 3rd ed. Amsterdam: Elsevier; 2008:43–54.
40. Jensen GM, Hack LM, Nordstrom T, Gwyer J, Mostrom E. National study of excellence and innovation in physical therapist education: Part 2-A call to reform. *Phys Ther.* 2017;97(9):875–888. <https://doi.org/10.1093/ptj/pzx062>.
41. Jensen GM, Nordstrom T, Mostrom E, Hack LM, Gwyer J. National study of excellence and innovation in physical therapist education: Part 1–Design, method, and results. *Phys Ther.* 2017;97(9):857–874. <https://doi.org/10.1093/ptj/pzx061>.
42. Jensen GM, Mostrom E, Shepard KF. Teaching and learning in academic settings. In: Jensen GM, Mostrom E, eds. *Handbook of teaching and learning for physical therapists*. 3rd ed. St. Louis, MO: ELSEVIER; 2013:36–62.
43. McGinty SM. Case-method teaching: an overview of the pedagogy and rationale for its use in physical therapy education. *J Phys Ther Educ.* 2000;14(1):48–51.