Clinical Reasoning Across the Continuum of Physical Therapist Education: A Blueprint for Teaching, Learning, and Assessment

Michelle Reilly, PT, DPT
Board Certified Specialist in Orthopedic Physical Therapy
Assistant Professor, Creighton University

Jennifer Furze, PT, DPT
Board Certified Specialist in Pediatric Physical Therapy
Associate Professor, Creighton University

Lisa Black, PT, DPT
Professor, Creighton University

Heather Knight, PT, DPT, CBIS
Board Certified Specialist in Neurologic Physical Therapy
Assistant Professor, Creighton University

Jessica Niski, PT, DPT
Board Certified Specialist in Pediatric Physical Therapy
Assistant Professor, Creighton University

Julie Peterson, PT, DPT
Board Certified Specialist in Women's Health Physical Therapy
Assistant Professor, Creighton University

Gail Jensen, PT, PhD, FAPTA
Professor, Creighton University
Adjunct Professor of Medicine, Center for Health Professions Education
Uniform Services University of Health Sciences, School of Medicine; Bethesda, MD

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INTRODUCTION/BACKGROUND AND PURPOSE:

Clinical reasoning (CR) is a complex process and foundational for all health professionals in clinical practice. Clinical reasoning, as understood in physical therapy, integrates cognitive, psychomotor, and affective skills as described in a recent concept analysis.[1] Important factors in this process include context of the situation and perspective of both the therapist and client. Reasoning is a dynamic and cyclical process resulting from collaboration as an approach to patient management.[1] This process allows physical therapists and other health professionals to make challenging decisions in the face of complex patient situations and uncertainty.[2] Thus, as a profession, there is a need to evaluate the development and progression of student clinical reasoning across the curriculum and to develop best practices for teaching, learning, and assessing CR.[1,3,4]

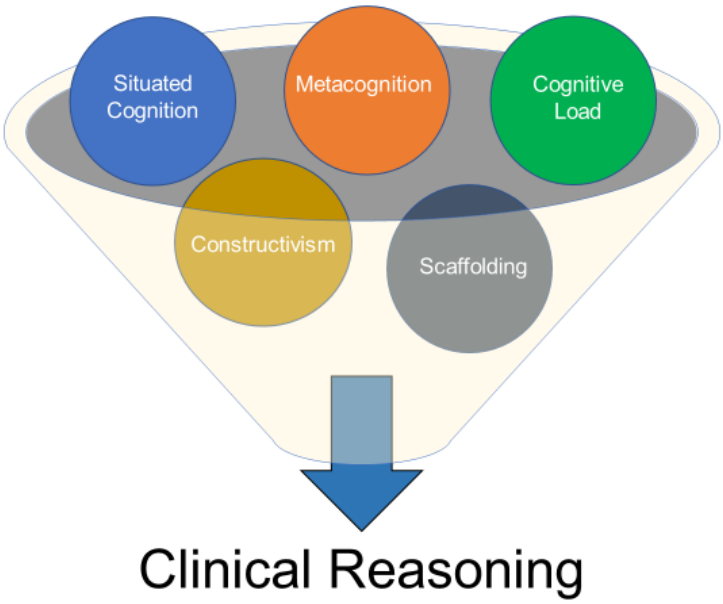
The purpose of this blueprint is to identify evidence-based CR teaching, learning, and assessment strategies for faculty, clinicians, and residents/fellows and to categorize these strategies across the educational continuum (beginner, intermediate, competent, and proficient). This educational resource was developed with both academic and clinical educators in mind to support a collaborative effort in developing practitioners who have sound clinical reasoning.

THEORETICAL GROUNDING

Educators, whether academic or clinical, should know and understand the theories that provide the foundation for teaching and learning strategies. Learning is complex and learning theories assist in serving as a lens through which educators approach learning experiences. The “lens” serves as a conduit to help educators apply appropriate teaching and learning strategies for the learners at different points in their development.[5] Cognitive, behavioral, cultural and contextual are the four domains of learning theories described by Murphy and Knight in 2016 and can serve as a “lens” that educators may view a teaching and learning experience. There is a tendency to over-emphasize cognition and behavior (just think of your own educational journey), yet all four lenses have application to learning clinical reasoning and the development of clinical knowledge in physical therapy.

The intent of the Blueprint is not for the educator to utilize all of the teaching and assessment tools identified below. Rather, the educator will need to narrow and think critically about which strategy will promote the optimal teaching and learning environment. The Blueprint is designed to make this an efficient process for the educator. As a starting point, below are summary descriptions of 5 teaching and learning theories described in The Cambridge Handbook of The Learning Sciences which are applicable to the assessment, teaching and learning of CR.[6]

- Situated Cognition: The learner's behavior is mediated by the physical and social environment. The context of the patient situation including personal and environmental factors of the ICF model, co-morbidities, and the social/cultural considerations should influence patient management decisions. This lends itself to the "it depends" conversations.
- Constructivism: Learning results from the creation of mental structures through play, active learning, and building connections centered on clinical practice.
- Cognitive load; Real time cognitive demands on the learner which increase or decrease learning. Load can be decreased by a structured case study that they are familiar with and segmenting into smaller chunks. Load can be increased by expecting the learner to integrate previous knowledge (pattern recognition), develop their own structure or identify missing information.
- Metacognition: The ability to monitor one's own ability to understand information and material.
- Scaffolding: Another person provides the learner with prompts and hints for specific components of a complex task so that the learner can figure out how to perform the task.



Revisiting the lens analogy, the concepts of cognitive load and metacognition are directly linked to the cognitive theory lens as they focus on thinking and the mental process of gaining knowledge. Situated cognition, constructivism, and scaffolding align with the social theories found in the cultural and context lenses. Educators should include teaching, learning and assessment strategies for CR across all lenses, and the blueprint may help educators focus on the less commonly addressed social learning theories and integrating cultural and contextual factors into the learning experience.

BLUEPRINT STRUCTURE

Four performance descriptors, identifying different learners within physical therapist education and across the educational continuum, are utilized in the blueprint. The performance descriptors (beginner, intermediate, competent, proficient) were first integrated with the domains of clinical reasoning (content knowledge, procedural knowledge and skill, conceptual knowledge and reasoning) in the development of the Clinical Reasoning Grading Rubric, now titled the Clinical Reasoning Assessment Tool (CRAT).[4,7] The CRAT serves as the organizational framework for this blueprint, creating twelve categories for evidence-based teaching and learning of CR (each domain of content knowledge, procedural knowledge and conceptual reasoning at each learning level of beginner, intermediate, competent and proficient). See Table 1 for detailed descriptions of the four levels of learners.

Table1. Performance Levels

Level of Learner	Performance Description
Beginner	Demonstrates limited evidence of foundational knowledge and application of ICF model, ability to select and perform tests and measures, and justify rationale behind these selections
Intermediate	Progresses from limited evidence and ability to moderate with the ability to justify a rationale for most test and measures.
Competent	Demonstrates strong evidence of knowledge and application, appropriately selects and accurately performs tests and measures with an ability to justify a rationale for all tests and measures. Can be equated to the entry-level physical therapist
Proficient	The highest performer who demonstrates comprehensive knowledge and application with efficiency in patient interaction and an ability to reflect in real time to make changes.

While these performance descriptors may align with year 1, year 2, and year 3 of professional education and category four with post-professional education, advanced learners or learners who are struggling may benefit from teaching and learning strategies in the category preceding or proceeding the timeframe outlined below.

Key dimensions of knowledge, originally described in 2002 as a revision to Bloom's taxonomy,[8] have been identified as key to the development of CR for physical therapists.[7,9] Table 2 defines the categories of knowledge used to organize this blueprint which were founded on this previous work.

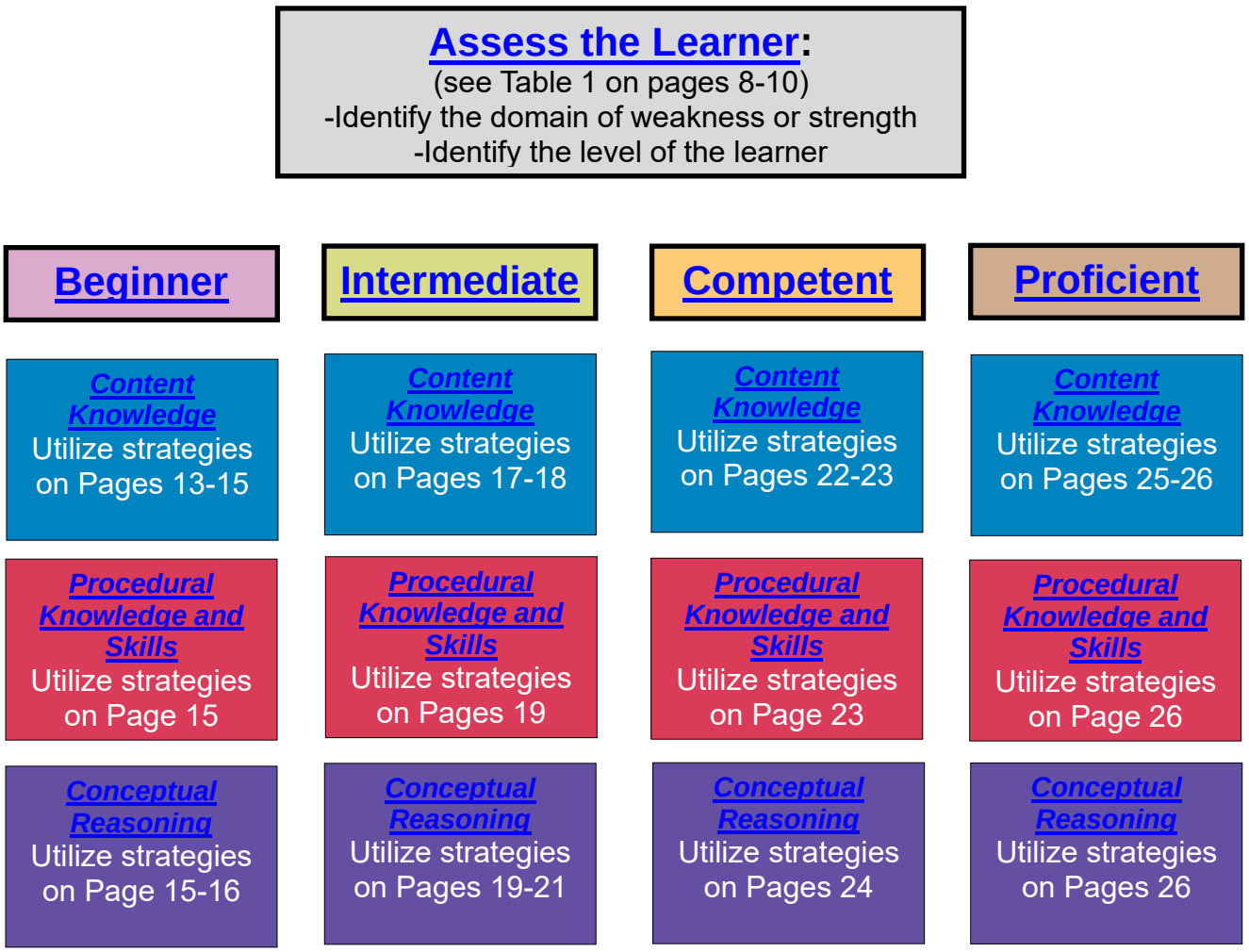
Table 2. Dimensions of Knowledge

Dimension of Knowledge	Descriptions
Content knowledge	The ability of the student/learner to identify appropriate foundational knowledge integral to the patient's health condition and facts and information related to the International Classification of Functioning, Disability, and Health (ICF) Framework.
Procedural Knowledge and Skill	the ability to determine the appropriate test/measure/ or intervention and the psychomotor performance of this intervention/test/skill. Essentially the student/learner needs to know what skills to perform, when to perform them, and how to perform the skill.
Conceptual Knowledge and Reasoning	the interrelationship and synthesis of information upon which judgment is made utilizing reflection and self-awareness. This is where the learner "puts the pieces of the puzzle together" and evaluates the patient as a whole.[7] Collaborative reasoning is included in this category as the therapist works with the patient and family to develop prioritized goals and interventions.[10]

Within the blueprint, educators will find a section focused on the assessment of clinical reasoning skills, which classifies assessment strategies based on these same 3 types of knowledge and skills. Additionally, within each learner category, educators can search for teaching and learning strategies based on the intention of facilitating the development of content knowledge, procedural knowledge and skills, or conceptual reasoning.

Figure 1: CR Blueprint Roadmap

Prior to determining the appropriate teaching and learning strategy, assessment of the learner's knowledge and skills (content knowledge, procedural knowledge and skills, and conceptual reasoning) should occur to identify the learner's performance level (beginner, intermediate, competent, proficient). Once a performance level is identified, specific strategies for teaching and learning can be matched to the domain of knowledge that needs addressed.



ASSESSMENT OF THE LEARNER

Action Statement/Summary: Assessment of clinical reasoning skills allows educators to develop a learner diagnosis by discerning areas of strength or areas that need remediation. Identifying inadequate knowledge and poor reasoning skills early is key for promoting success for health professional students.[11] Assessment strategies can focus on specific types of knowledge that contribute to clinical reasoning, including content knowledge, procedural knowledge, and conceptual reasoning, which allows educators to select teaching and learning strategies that address gaps in the reasoning process. Multiple assessment strategies should be utilized to gain a better understanding of how the learner is organizing information and responding to information in different circumstances.[12] Educators should also consider developing rubrics to guide faculty evaluation and provide structured feedback on the reflective learning process.[13]

Table 3: Assessment of the Learner- This table serves as a summary list of options for assessing learner performance in the areas of content knowledge, procedural knowledge and skills, and conceptual reasoning. Please refer to the text below the table for definitions of assessment strategies, specific examples, and references

Content Knowledge	1. Assessment of pre-clinical students focuses on written evaluation and test questions related to foundational knowledge.[14] 2. Assess foundational knowledge with exam questions. Longitudinal testing of key concepts is supported.[15] 3. Implement think aloud opportunities,[16] including an interview think aloud format.[17] 4. Utilize the Brief Risk Information Skill (BRISK) scale to assess clinical risk of communication competence.[18] 5. Ask the learner to develop a prioritized problem list with the associated plan of treatment to assess CR while on clinical experiences.[19] 6. The Outcome Present State Test Model is used to assess CR after students create a "CR Web". This is a new evaluation strategy that requires additional validation testing.[20] 7. Utilize the Objective Structured Practical Examination (OSPE) tool to assess CR foundational knowledge during a practical exam.[21] 8. When in a clinical setting, observation of the learner during patient interactions to provide meaningful opportunities to evaluate knowledge.[22, (Phillips, 2016)] 9. The Evolving Script Concordance Test has been described in the medical literature to assess foundational knowledge.[24-30] 10. Utilize simulated patients or vignettes to create opportunities to evaluate clinical reasoning abilities.[31] The tools below were used in this study to measure clinical thinking skills. California Critical Thinking Disposition Inventory/California Critical Thinking Skills Test 11. Utilize faculty simulation of patient cases during OSCE.[32] 12. Integrate computer simulated cases into the classroom environment to assess CR. Educators in physical therapy can utilize a tool to measure reasoning such as the HSRT,[33] or the virtual patients can be utilized to create opportunities for formative self-assessment.[34] 13. Diagnostic Thinking Inventory[35] 14. Clinical Reasoning Grading Rubric[4,7] 15. Clinical Integrative Puzzle can be utilized to assess a learner's ability to organize information in clusters by utilizing a grid format.[36]

	16. Think Aloud Standardized Patient Examination (TASPE) tool provides a standardized method to assess clinical reasoning skills during a standardized patient examination. While this new tool that was developed within physical therapy education shows potential, it still needs validity and reliability testing.[37] 17. Utilize a self-assessment tool for clinical decision making to gain insights into learners' perceptions of their own knowledge and clinical reasoning skills.[38]
Procedural Knowledge and Skills	1. Simulated patients or faculty simulation of patient cases can be utilized to assess psychomotor skills during an OSCE and provide direct feedback after the experience.[32] 2. Objective Structured Practical Examination (OSPE) tool is described in the chiropractic literature as a means for assessing skills during a practical exam.[21] 3. Quantitative Evaluation Tool - Guided Rubric for Student Assessment in Simulation Activities[39] 4. Lasater Clinical Judgement Rubric (LCJR) is a valid assessment in nursing[40-47]; LCJR was validated for self-assessment on high fidelity simulation[48]; LCJR is a valid tool for assessment of CR in clinical education environment.[49] 5. The Observational Assessment Tool is a rubric with 4 domains of assessment including problem solving process, disciplinary knowledge, character of discussion, and communication.[50] 6. Clinical Reasoning Grading Rubric[4,7] 7. Standardized patients are feasible way to assess CR the learner's procedural knowledge.[51,52] 8. Think Aloud Standardized Patient Examination (TASPE) tool provides a standardized method to assessing clinical reasoning skills during a standardized patient examination. While this new tool that was developed within physical therapy education shows potential, it still needs validity and reliability testing.[37] 9. Utilize a self-assessment tool for clinical decision making to gain insights into learners' perceptions of their own procedural knowledge and clinical reasoning skills.[38]
Conceptual Reasoning	1. Implement concept maps.[9] 2. Implement think aloud opportunities,[16] including an interview think aloud format[2] 3. Provide videotaped feedback following skill demonstration to create a learner centered form of assessment[53] 4. Utilize patient cases as an active assessment in addition to standardized assessments such as an objective structured clinical examination (OSCE) to provide a student centered assessment approach that provide points for quality of performance and clinical reasoning during the case interactions.[54] 5. Integrate small group interactions using peer to peer feedback[14] 6. When in a clinical setting, observation of the learner during patient interactions can provide meaningful opportunities to evaluate knowledge.[22,23] 7. Quantitative Evaluation Tool - Guided Rubric for Student Assessment in Simulation Activities[39] 8. Lasater Clinical Judgement Rubric (LCJR) is a valid assessment in nursing[40-47] 9. The Evolving Script Concordance Test[24-30,55] 10. Diagnostic Thinking Inventory[35] 11. Clinical Reasoning Grading Rubric[4,7] 12. Utilize simulated patients or vignettes to create opportunities to evaluate clinical reasoning abilities,[31] Utilize faculty simulation of patient cases during OSCE.[32] 13. Integrate computer simulated cases into the classroom environment to assess CR. Educators in physical therapy can utilize a tool to measure reasoning such as the HSRT,[33] or the virtual patients can be utilized to create opportunities for formative self-assessment.[34] 14. Standardized patients are feasible way to assess CR.[51,52] 15. Have real clients to ask the learner to identify priority areas and the associated plan of treatment to assess CR while on clinical experiences.[19] 16. A Clinical Integrative Puzzle can be utilized to assess a learner's ability to organize information in clusters by utilizing a grid format.[36]

17. Think Aloud Standardized Patient Examination (TASPE) tool provides a standardized method to assessing clinical reasoning skills during a standardized patient examination. While this new tool that was developed within physical therapy education shows potential, it still needs validity and reliability testing.[37]
18. Utilize a self-assessment tool for clinical decision making to gain insights into learners' perceptions of their own procedural knowledge and clinical reasoning skills.[38]

Strategies for Assessment:

Content Knowledge:

1. Definition of Think Aloud: Describing one's thought process during an activity. This might include thinking aloud during a patient/client encounter or during a specified learning activity.[37]
   Notes: While completing an initial examination of a case, and faculty ask probing questions to gain further understanding of the student's depth of content knowledge.

2. Script Concordance Test has been described in the medical literature to assess foundational knowledge.[34-30,55]
   Notes: This electronic process for sharing evolving information about a case can be modified into an evolving case presentation in the classroom where the educator provides similar, conceivable diagnoses based on a patient's presentation. To get to the correct diagnosis, the learner has to request and explore additional information. This provides a level of "uncertainty" of which is required of competent clinicians.

3. OSCE[32]
   Notes: An Objective Structured Clinical Examination (OSCE) provides a formal and structured way for assessing clinical skills which traditionally consists of stations to assess different skills. Faculty could simulate a variety of patient cases at different stations to assess content knowledge on different health conditions.

4. Diagnostic Thinking Inventory[35]
   Notes: Present a case and ask students to respond to questions to gain a general understanding of how a student is thinking about the case.

5. Clinical Reasoning Grading Rubric[4,7]
   Notes: Utilize the rubric on an end of the semester practical exam. If integrated every semester it will allow for a progression from beginner to competent from the start of the program to graduation.

6. Clinical Integrative Puzzle[36]

Notes: A Clinical Integrated Puzzle requires learners to organize answer options into rows and column. For example, the rows might require the learner to connect the option to the correct health condition and the columns might require the learner to connect the option to the domain where the information might be gathered during an initial examination.

Procedural Knowledge & Skills:

1. Lasater Clinical Judgement Rubric (LCJR)[40-47]

Notes: LCJR was validated for self-assessment on high fidelity simulation.[48]

LCJR is a valid tool for assessment of CR in clinical education environment.[49]

2. Clinical Reasoning Grading Rubric[4,7]

Notes: Utilize the rubric on an end of the semester practical exam. If integrated every semester it will allow for a progression from beginner to competent from the start of the program to graduation.

Conceptual Reasoning:

1. Implement concept maps.[9]

Notes: Definition of a Concept Map: A visual representation of how knowledge is organized or connected.

Example: Students are provided a list of motor learning terms/concepts (e.g. task, patient, environment, implicit learning, explicit learning, performance, procedural learning, associative learning, nonassociative learning, classical conditioning, operant conditioning, habituation, encoding, consolidation, storage, retrieval, retention test, transfer test). They are then asked to draw a schematic for how they determine which approach to implement to enhance motor learning based on a client's cognitive abilities. A large group discussion is then held to compare and contrast motor learning strategies using different case scenarios with patient scenarios presenting with various cognitive abilities.

2. Implement think aloud opportunities,[16] including an interview think aloud format[17]

Notes: Students are asked to complete an examination of a case, and faculty ask probing questions to get at thought processes during the examination process.

3. Integrate small group interactions using peer-to-peer feedback.[14]
   Notes: Have students grade small group participation as satisfactory/unsatisfactory were unsatisfactory is assigned for silent presence or contributions that are not meaningful.
   Use peer teachers in the small group process and the teachers are graded on their level of preparation and leadership.

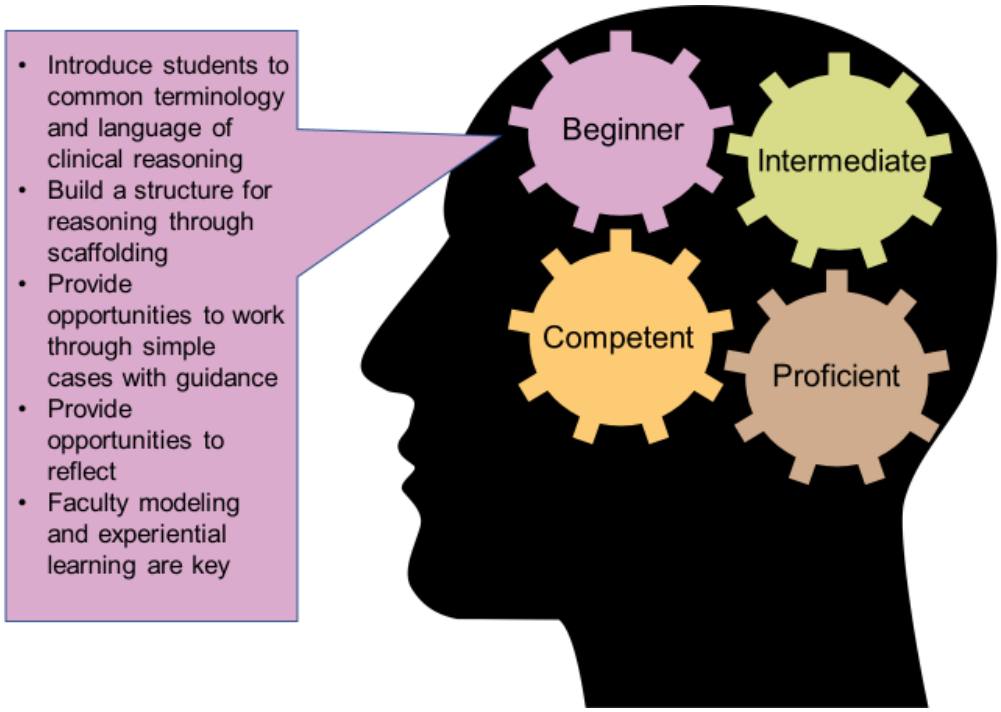
4. When in a clinical setting, observation of the learner during patient interactions can provide meaningful opportunities to evaluate knowledge.[22,23]
   Notes: Listen to the patient education that is being provided by the learner to assess if the rational provided for recommendations is consistent with the patient's clinical presentation and examination findings.

5. Quantitative Evaluation Tool - Guided Rubric for Student Assessment in Simulation Activities[39]

6. Lasater Clinical Judgement Rubric (LCJR) is a valid assessment in nursing[40-47]
   Notes: LCJR was validated for self-assessment on high fidelity simulation.[48]
   LCJR is a valid tool for assessment of CR in clinical education environment.[49]

TEACHING AND LEARNING FOR THE BEGINNER LEARNER

Action Statement/Summary: There is a need to introduce students to the common terminology and language of CR and build structure of their reasoning through scaffolding. Educators should provide opportunities to grapple with simple cases with guidance from advanced learners and provide an opportunity to reflect on the experience to start forming a process for metacognition. Faculty modeling and experiential learning are key for integrating situated learning.



Teaching and Learning Strategies	Learning Concepts	Examples
Target Domain: Content knowledge		
Explicit description of CR and CR theory[9,14,56,57]	Scaffolding	Presentation of the ICF model, patient/client management model or other reasoning model in a lecture setting provides students with a common language and framework for decision making. At this level of learner, the educator provides the information in these categories and demonstrates application of the preferred model. Terminology from these frameworks should be consistently threaded through laboratory and class discussion.
	Constructivism	Introduce clinical reasoning concepts and principles with clear definitions and examples. Initial discussion may focus on definitions of clinical reasoning, types of reasoning used by therapists and reflection processes. The educator should

		work to link clinical reasoning to concepts the learner is familiar with and encouraging students to identify connections.
Discuss case scenarios in small groups with faculty guidance and feedback.[58-61]	Situated Cognition	Students are provided with basic case information prior to a class session and asked to develop potential differential diagnosis hypotheses and a plan for physical therapy examination. During the session, students work in small groups to role play the case with an educator in a dual role of patient and instructor. The educator can provide data from the patient perspective while simultaneously guiding discussions related to specific questions to ask during the patient history, selection of the most appropriate tests and measures and considerations of the personal and environmental factors.
	Constructivism	Students are provided a basic case and take turns role playing the part of the PT and the part of the patient in diads with each partner getting information specific to their role. Small group debriefing with 3-4 diads after this exercise can provide guidance and feedback.
	Cognitive Load	Early cases should be simple and straightforward to alleviate cognitive overload. Consider using "textbook" type patient presentations for case scenarios.
Model clinical reasoning using Think Aloud and Clinical Reasoning Theater techniques[62,63]	Situated Cognition	An authentic patient/client is evaluated by a resident or advanced learner in front of novice learners. The advanced learner uses "time outs" to explain their clinical decisions ("I chose to do *x* technique because of *y* patient case factor"). Faculty can also use "time outs" to clarify reasoning, ask probing questions or present "what if" scenarios.
	Metacognition	Learners may participate in the "time outs" by asking clarifying questions of the resident of advanced learner.
	Cognitive Load	Early cases should be simple and straightforward to alleviate cognitive overload. Consider using "textbook" type patient presentations for case scenarios.
	Scaffolding	Following presentation of a patient case, faculty should "walk" the novice learner through initial utilization of planning documents or frameworks (patient management model, ICF framework) to assist the learner in "chunking" information and share their thoughts and decision-making processes.
Compare/contrast basic cases[58]	Situated Cognition	Multiple cases with common threads should be presented to learners to create foundational schemas. Small or large group debriefing can be used to discuss expected outcomes of specific exam procedures for each diagnosis.
	Constructivism	Learners are asked to "think backwards" from a given diagnosis to determine a typical patient presentation, subjective report, and examination findings. Educators can present other potential diagnoses that could present similarly and what could be used to differentiate. Use of games, including jeopardy or family feud, utilize active

		learning strategies and encourage learners to think differently about content.
	Cognitive Load	Limit compounding variables in early cases. Assume a "perfect world" for the case.
Audience response system and case-based discussion[64]	Constructivism	After a simple patient case is presented, learners are asked to respond to a multiple-choice question via an electronic audience response system. Once all learners have voted, the educator can lead a discussion around which answer might be the best or most appropriate response. Discussion around why the other answers are not the best choice should also be discussed. The educator has an opportunity to clarify any gaps in content knowledge based on the group responses.
	Cognitive Load	Early cases should be simple and straightforward to alleviate cognitive overload. Questions used with audience response systems should incorporate only 1-2 concepts.

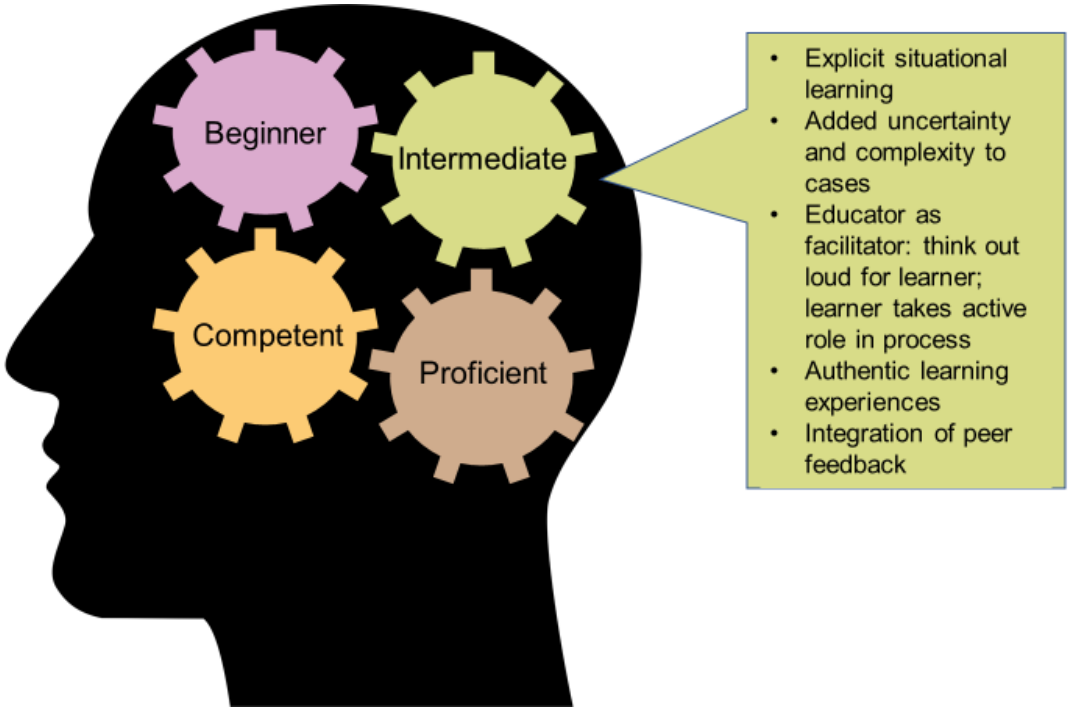
Target Domain: Procedural Knowledge
Evidence is lacking on the development of procedural knowledge for a beginning learner.

Target Domain: Conceptual Reasoning		
Experiential learning integrated with reflection and structured debrief.[57,61,65-67]	Situated Cognition	Involve learners in a basic simulation experience with a standardized patient to role play a basic patient case. Require students to plan a basic interview, expected tests and measures as well as potential barriers to evaluation prior to beginning the experience. While learners use their established plan during the simulation, they are encouraged to adapt their interview or tests and measures based upon patient's response.
	Cognitive Load	Learners work in diads/triad to reduce individual expectations and create an atmosphere of cooperation. Educators should consider ways to make the experience low risk to minimize emotional responses.
	Metacognition	Following the experience, learners participate in a small group debrief with directed feedback related to performance and reflection related to what went well, where they have room to improve and what they would change if they were to repeat the exercise.
Introduce Basic Illness Scripts[68]	Scaffolding	Early courses should introduce "textbook" presentations of health conditions which are reinforced with case presentations including typical patient reports and very little patient variation. The educator works with the students to identify expected outcomes for the tests and measures. Consistent headings (mechanism of injury,

	subjective complaints, objective findings, etc) are used to provide a structure for learners while the educator fills in information to build a scaffold.
Cognitive Load	When first introducing illness scripts, the student may only be responsible for identifying 1-2 typical findings for a diagnosis, with peers, teachers or advanced learners contributing the other defining characteristics.
Constructivism	Allow students to role play the patient presenting with typical patient presentations while a second student/group of students attempts to identify the diagnosis.

TEACHING AND LEARNING FOR THE INTERMEDIATE LEARNER

Action Statement/Summary: Situational cognition should be very explicit during this stage. Educators should add uncertainty and complexity into cases and consider thinking out loud for the learner. The teacher is viewed as a facilitator, so the learner takes more of an active role in the learning process. Scaffolding of information is still beneficial while encouraging students to look at the big picture for the case. Authentic learning experiences are key in this year with the literature supporting integrated clinicals or interacting with real clients. Integrating peer feedback as part of the learning experience is also a key component of assessment during this phase of development.



Teaching and Learning Strategies	Learning Sciences	Examples
Target Domain: Content Knowledge		
Concept Map[69-71]	Constructivism	Students may be provided a list of terms/concepts (e.g for motor learning terms might include task, patient, environment, implicit learning, explicit learning, performance, procedural learning, associative learning, non-associative learning, classical conditioning, operant conditioning, habituation, encoding, consolidation, storage, retrieval, retention test, transfer test). They are asked to create a schematic drawing that represents how these terms are connected.

Contextual Learning[59,72-76]	Metacognition & Scaffolding	A large group discussion might be facilitated following the creation of a concept map which allows the learner to compare and contrast their own thoughts on how the terms were connected with the thoughts of their peers. An example concept map by a more experienced clinician can also allow the learner to compare their reasoning process to a more advanced thought process.
	Situated Cognition	Create opportunities for simulation, virtual patients, clinical and service learning experiences, or case based activities that allow the learner to integrate patient specific information across all levels of the ICF model including personal and environmental factors. Ideally, the learner is expected to respond in real time to new information presented by the patient.
Audience Response System and case-based questions[64]	Scaffolding	After a case is presented, learners may be asked to respond to a multiple-choice question via an electronic audience response system. This activity can be an individual competition or a group activity which allows learners to earn points for accuracy and/or speed to create a friendly game atmosphere. Once all learners have voted, the educator leads a discussion around which answer might be the best or most appropriate response. Discussion around why the other answers are not the best choice should also be discussed.
	Cognitive Load	The educator should adjust the complexity of the case to meet the needs of the learner and their existing knowledge. The case questions asked via the audience response system may build on each other to strategically increase the depth of thought and discussion around the factors impacting the clinical decision if the learner can integrate this information in a meaningful way. Any gaps in content knowledge based on the groups' responses to questions posed should also be addressed in the discussion.
Explicit description of CR[67,77]	Scaffolding	Use of explicit clinical reasoning terminology and concepts that were presented in beginner level curriculum should be reinforced in the second year to continue to enhance knowledge and awareness of reasoning process with more complex cases and less coaching from faculty (Geisler & Lazenby, 2009).
Translate strategies from classroom to clinical setting[78]	Situated Cognition	The clinical educator may ask a learner to respond to "what if" scenarios around specific patient cases to allow for conversation around how patient specific factors might change the decision-making process.
	Cognitive Load	The clinical educator may elect to ask students to respond to knowledge probes related to their clinical reasoning around a patient case in a back room away from the patient where the learner is in a "Safe environment" and does not feel pressure to answer questions in front of the patient.

Target Domain: Procedural Knowledge		
Experiential Learning including simulation[72,75] or clinical experiences[72-74]	Situated Cognition	Facilitate interaction with real clients through pro bono clinics, service-learning opportunities in labs like balance clinics, or the integration of clinical education experiences to allow the learner to practice handling skills on people with real movement dysfunction. An emphasis on how the contextual factors of the patient experience changed the student's clinical reasoning process.
	Cognitive Load	Create opportunities for faculty simulation and standardized patients to provide students with more realistic patient interaction in a less stressful environment and to perform psychomotor skills in a more clinically relevant situation.

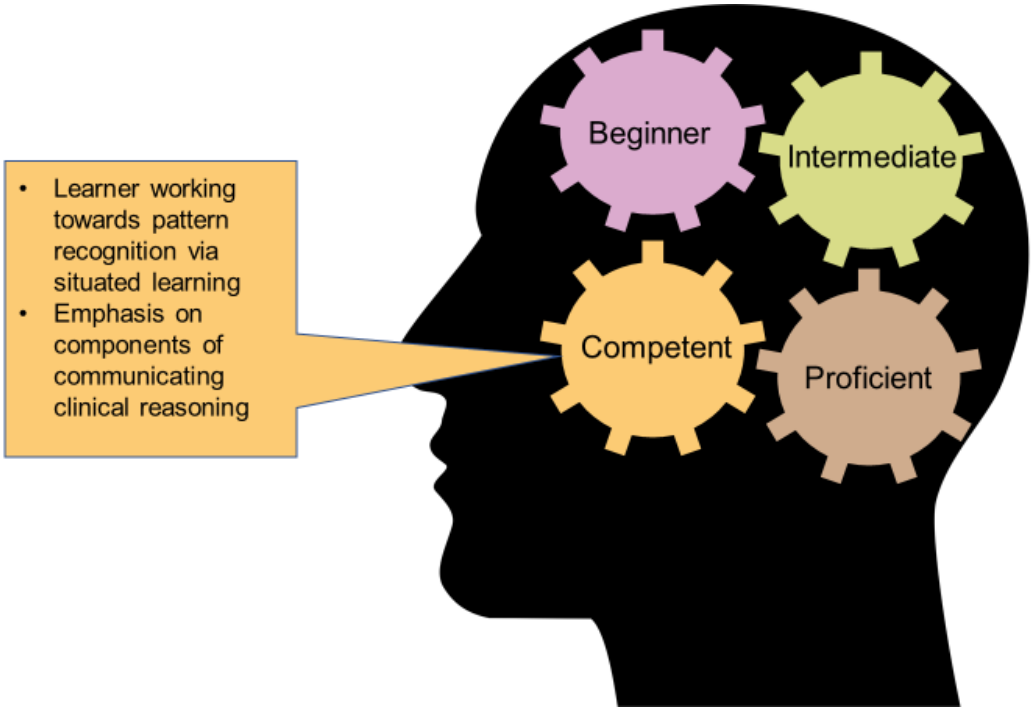
Target Domain: Conceptual Reasoning		
Concept Map[69-71]	Constructivism	Students may be provided a list of terms/concepts (e.g for motor learning terms might include task, patient, environment, implicit learning, explicit learning, performance, procedural learning, associative learning, non-associative learning, classical conditioning, operant conditioning, habituation, encoding, consolidation, storage, retrieval, retention test, transfer test). They are asked to create a schematic drawing that represents how these terms are connected.
	Metacognition & Scaffolding	A large group discussion might be facilitated following the creation of a concept map which allows the learner to compare and contrast their own thoughts on how the terms were connected with the thoughts of their peers. An example concept map by a more experienced clinician can also allow the learner to compare their reasoning process to a more advanced thought process.
Contextual Learning[59,72-76]	Situated Cognition	Create opportunities for simulation, virtual patients, clinical and service learning experiences, or case based activities that allow the learner to integrate patient specific information across all levels of the ICF model including personal and environmental factors. Ideally, the learner is expected to respond in real time to new information presented by the patient.
Audience Response System and case-based questions[64]	Scaffolding	After a case is presented, learners may be asked to respond to a multiple-choice question via an electronic audience response system. This activity can be an individual competition or a group activity which allows learners to earn points for accuracy and/or speed to create a friendly game atmosphere. Once all learners have voted, the educator leads a discussion around which answer might be the best or most appropriate response. Discussion around why the other answers are not the best choice should also be discussed.

Illness scripts[14,68]	Cognitive Load	The educator should adjust the complexity of the case to meet the needs of the learner and their existing knowledge. The case questions asked via the audience response system may build on each other to strategically increase the depth of thought and discussion around the factors impacting the clinical decision if the learner can integrate this information in a meaningful way. Any gaps in content knowledge based on the groups' responses to questions posed should also be addressed in the discussion.
	Scaffolding	The educator can help the learner organize their thoughts by creating illness scripts that that draw the learner's attention to key components of the case. The educator may ask the learner to create a list of different diagnoses or patterns of key subjective elements based on the case presented in the illness script.
	Situated Cognition	The educator may develop a series of 2-3 cases which consist of different health conditions, but the personal factors associated with the case might be similar. Learners are asked to make formal recommendations based on the information presented on each case and provide a justification for the recommendation. The educator then leads a large group discussion which allows learners to compare and contrast the cases and organize thoughts around how personal factors might change the physical therapist's recommendation.
Progression from simple to complex cases[14,79]	Scaffolding	Techniques such as the SNAPPS model, creating a SOAP note, or using the ICF model may help the learner organize information when exposed to progressively more complex cases. (Trowbridge et al., 2015)
Introducing uncertainty[56]	Situated Cognition	Move from simulation towards real patient/client interactions with integration of complex clinical presentations that require the learner to reflect-in-action and incorporate contextual factors.
	Metacognition	The learner may be asked to complete a reflection during clinical experiences about what went well, what could they improve on, and what can they recognize with patients if they see this clinical presentation again.
Emphasis on learning from patient's story[74]	Situated Cognition	Following a patient/client interaction, the learner may be asked to use information from the subjective exam about specific contextual situations related to the patient or the objective exam to justify his or her decision-making process.
Increasing student responsibility[74]	Cognitive load	The clinical instructor serves as a coach while the learner is expected to increase their role in the decision-making process for patient management. Expectations are agreed upon ahead of time by the educator and learner that the learner will respond to the patient's questions and needs for education before the educator responds.

Script Concordance Test[80]	Constructivism	Script Concordance Test can be used to facilitate deeper discussions around case examples by unfolding information about a case over time. (Funk et al., 2017) Strategies for a Script Concordance Test could include computer or paper- based scenarios where the learner is provided a case presentation and asked to construct and develop data. Follow up information is provided based on the learner's clinical decision with an expert providing variations in data interpretation based on contextual factors.
Supplemental curriculum during clinical experiences[81]	Situated Cognition	Interactive case-based sessions can be delivered on topics relevant to the clinical setting and explicit factors relevant to that clinical context are discussed.

TEACHING AND LEARNING FOR THE COMPETENT LEARNER

Action Statement/Summary: The learner should be working towards pattern recognition via situated learning. This may include simulation, clinical experiences, and working directly with clients. Emphasis should be on communication factors including active listening, integration of dialogue around contextual factors, role modeling, and professional socialization.



Teaching and Learning Strategies	Learning Sciences	Examples
Target Domain: Content Knowledge		
Explicit description of CR progression[9,56]	Scaffolding	Use patient case scenarios during didactic examinations as written with complexity based on learner development. The educator can provide additional thoughts and insights to help the learner identify components of pattern recognition.
Integrate core components of communicating CR[13,78,81,82]	Scaffolding	SNAPPS model or 1-minute preceptor in clinical care to initiate dialogue between students and CI's; Provide specific learning activities to stimulate higher-order thinking such as vignettes that have been derived from strategies in the literature to solve problems and help the learner develop and synthesize information. Enhance thinking and increased competence through structured and thoughtful faculty feedback using a rubric for reflections on clinical experiences or structured

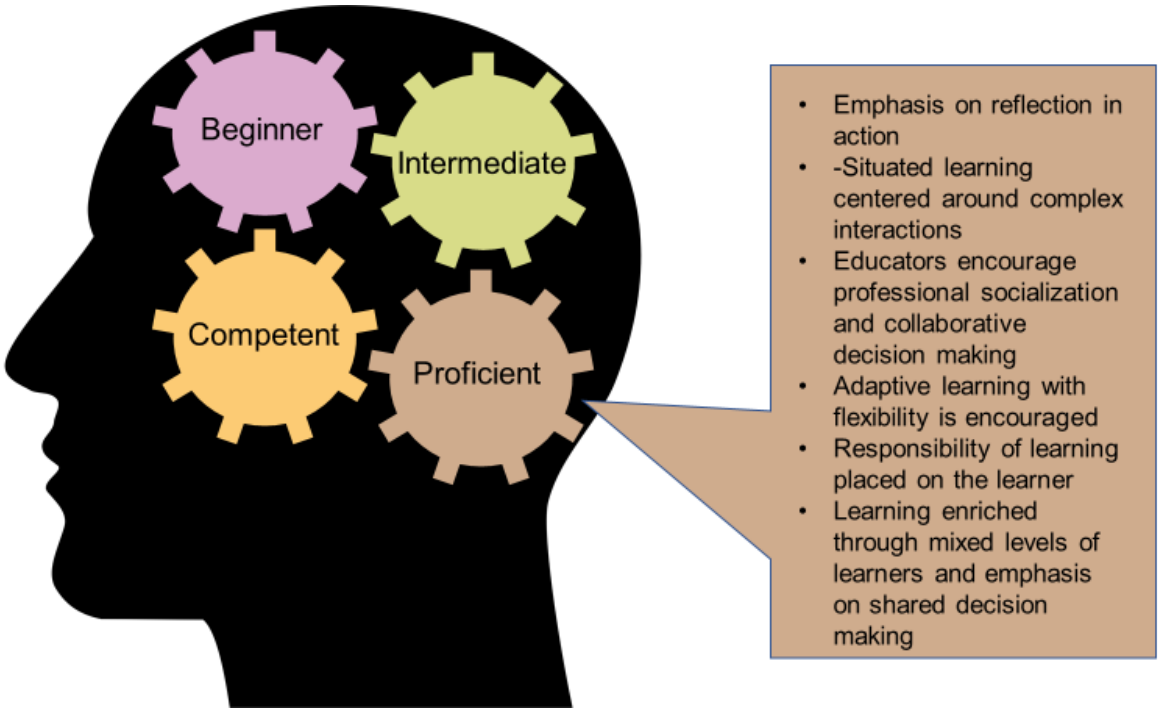
		patient cases in lab (ie. Tanner's Clinical Judgment Model)
	Constructivism	Assign students to a live patient in lab where the students complete the initial evaluation and design a plan of care. Students will then follow up with the patient 4-6 sessions and consider elements of discharge planning. At the completion of lab sessions, the students present their patient case to the class including elements of the initial evaluation, plan of care, treatment, and discharge.

Target Domain: Procedural Knowledge		
Repetition[83,84]	Cognitive load	Students complete a high number of repetitions with practice in lab, practical examinations, and skills competency tests as well as through clinical experiences
Reflection in action[9]	Metacognition	Educate CI's through online modules or continuing education classes on mentoring competent students to challenge their reflection in action
	Scaffolding	Integrate SNAPPS model or 1-minute preceptor to improve procedural knowledge of delivery of care during clinical education experiences
Professional Socialization[56]	Metacognition	Seek student reflection on an advocacy issue (i.e. therapy cap repeal) in the didactic curriculum through seminars with invited guests/speakers that have knowledge around an advocacy issue
	Situated Cognition	Faculty demonstrates and models a commitment to state and national organizations through membership, attending meetings, and representation on committees including networking with other therapists
Integrate core components of communicating CR[82]	Constructivism	Incorporate residents into labs providing mentorship to students to challenge their CR and then have students do a case presentation to the class about a patient presentation based on what they are studying in lab
Role Modeling[56]	Constructivism	Have students participate in faculty or student led research in the PT department to create new knowledge Second and third year students model professional behaviors and commitment to service to first year students through planned service projects (i.e. Joint Volleyball) and then first year students develop their own project.

Target Domain: Conceptual Reasoning		
Situated Learning[24,56,83,84]	Situated cognition	Utilize Evolving Illness Scripts in the classroom so that the story unfolds and the learner justifies how they would change their plan of care based upon the patient factors.
Professional socialization[56]	Situated cognition	Require attendance at professional events where advanced learners model professional behaviors to younger students (i.e. State Legislative Day at the Capitol)
Inductive reasoning[9]	Constructivism	Incorporate a project on population health for the advanced student(s) so that one individual health problem is extrapolated to the entire population
Role modeling by faculty[9]	Metacognition	Design reflection questions/assignments to ask students to reflect upon the importance of faculty involvement in university, community, state, and national levels.

TEACHING AND LEARNING FOR THE PROFICIENT LEARNER

Action Statement/Summary: Similar to the competent level of learning, emphasis should be placed on reflection-in-action with situational learning centered around complex client/patient interactions. Educators should continue to encourage professional socialization and dialogues with other professions in collaborative decision making. Adaptive learning with flexibility in mind is encouraged and responsibility of learning is placed on the learner. Mixing the levels of learners and emphasizing shared decision making will enrich learning opportunities.



Teaching and Learning Strategies	Learning Sciences	Examples
Target Domain: Content Knowledge		
Explicit description of CR[56]	Cognitive load	Include CR definition, theory, application to clinical practice, types of CR, facilitating and assessing CR as part of the resident's didactic curriculum. Expand upon the details provided previously to earlier learners as the proficent learner should be able to grapple with more details.
Concept map[56]	Constructivism	Residents develop a concept map of their own CR at the beginning of the residency year and again at the end of their program

Mentor Feedback Forms[56]	Scaffolding	Residents complete mentor feedback forms for self- reflection about patient care throughout the residency program; mentors then provide feedback about the resident's CR process
Inductive Reasoning[9]	Metacognition	Residents complete clinical narratives, a form of reflection, throughout the residency program to facilitate progression of CR from deductive to inductive reasoning
Integrate core components of communicating CR[82]	Scaffolding	Include the five core components of communicating clinical reasoning as part of the resident's didactic curriculum as well as to educate the mentors on these components in order to reinforce communication

Target Domain: Procedural Knowledge		
Repetition of handling skills[83,84]	Cognitive load	Provide clinical opportunities for hands on interaction with patients with high number of repetitions in specialty area of residency
Reflection in action[9,85]	Metacognition	Mentor provides questions to resident about strengths and areas to improve upon related to patient handling skills during mentor session
Professional Socialization[56]	Situated Cognition	Create opportunities for PT residents and OT fellows to collaborate and learn from each other through a common didactic curriculum (ie. Example: A common curricular topic could be on communication strategies within a healthcare team)
Role Modeling by mentors and faculty[56]	Scaffolding	Mentors/faculty explicitly model behavior and handling skills that are expected of the learner during clinical interactions

Target Domain: Conceptual Reasoning		
Situated learning[24,86]	Situated cognition	Evolving Illness Scripts in which the resident discusses the uncertainty of the case within a safe environment with the mentors or residency faculty (i.e. Example: the learner would be presented with a clinical story with limited information yet seeking feedback about the current problem list. Additional information is then provided to the learner and they are asked if they would change anything with this additional information)
	Scaffolding	Residents present case presentations to faculty and peers with questions prompting next steps in patient care for discussion
Inductive reasoning[9]	Metacognition	Mentors can ask reflective questions of residents about pattern recognition after seeing multiple patients with the same or similar diagnoses

GLOSSARY OF TERMS

- **Audience Response System:** Tools (may be web based or specific software) that allow the audience to interact with the presenter using personal computing devices (phones, tablets, computers) or “clickers” by responding to multiple choice questions, polls or short text entry questions. Aggregate data from all responders is typically displayed by the presenter.
- **Clinical Integrated Puzzle:** Requires learners to organize answer options into rows and columns.
- **Clinical narratives:** the narrative process allows one to “see the resident’s thinking” and help assess and facilitate the clinical reasoning process. Narrative reasoning allows an understanding of the patient’s illness, experience, story, context, belief, and culture. This is necessary to interpret the actions of others and respond to the social context.
- **Clinical Reasoning Theater:** describes an activity in which a skilled provider interacts with a patient while “thinking out loud” about his/her clinical reasoning and engaging students in the decision-making process.
- **Common Curriculum:** describes a didactic curriculum in the residency program in which all residents in a program from different specialty areas of practice and possibly different health post-professional students join together to learn, discuss, and apply various topics applicable to all disciplines of a healthcare team.
- **Constructivism:** Learning results from the creation of mental structures through play.
- **Cognitive load:** Real time cognitive demands on the learner which increase or decrease learning. Load can be decreased by a structured case study that they are familiar with and segmenting into smaller chunks.
- **Concept Maps:** A visual representation of how knowledge is organized or connected.
- **Illness Scripts:** An organized summary of one’s knowledge about a patient case.
- **Mentor Feedback Forms:** the resident completes a written reflection on the chart review, plans for examination, reassessment, and interventions, goals, what went well and what was unsuccessful. The mentor then provides written and/or verbal feedback regarding the learner’s clinical reasoning.
- **Metacognition:** The ability to monitor one’s own ability to understand information and material.
- **Objective Structured Clinical Examination (OSCE):** Developed in medical education to provide a formal and structured way for assessing clinical skills. An OSCE often consists of stations that assess different skills.
- **1-minute preceptor model:** The one-minute preceptor teaching model consists of five steps that cover a supervisory encounter from start to

finish. The five steps include get a commitment, ask questions to gather supporting evidence, teach a general rule or concept, include positive reinforcement, and provide formative feedback.

- **Scaffolding:** Another person assists the learner in breaking the information down so that the learner can perform more complex tasks than the learner can do individually.
- **Script Concordance Test (SCT):** The intention behind the electronic script concordance approach is to simulate authentic conditions of medical practice, in which courses of action or lines of thinking about specific clinical problems are seldom indisputable, even among experts. Although case vignettes can never reflect the full complexity of real-patient encounters, SCT makers are instructed to generate questions from representative cases seen in daily practice. In some instances, audiovisual materials, including video segments, have been used to enhance the authenticity of the test-taking experience.
    - Evolving Scripts Concordance Testing is a method of assessing clinical reasoning in the learner through designing a clinical story that unfolds at different stages. As the story unfolds, the learner should have a clearer understanding for clinical decision making based on the clinical presentation. (i.e. Evolving Illness Scripts)
- **Situated Cognition:** The learner's behavior is mediated by physical and social environment. This lends itself to the "it depends" conversations.
- **SNAPPS model:** A model to promote efficiency for mentoring and facilitating clinical reasoning within a clinical setting. Key components of the model include Summarize briefly, Narrow the possibilities, Analyze, Probe with questions, Plan management, and Select a case-related issue.
- **Think Aloud:** Describing one's thought process during an activity. This might include thinking aloud during a patient/client encounter or during a specified learning activity

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