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Effect of Case Presentation on Physical Therapy Students' Clinical Reasoning

Nicholas LaRosa

A dissertation submitted to the department of Leadership, School Counseling, and Sports Management in partial completion of the requirements for the degree of

Doctor of Education in Educational Leadership

UNIVERSITY OF NORTH FLORIDA

COLLEGE OF EDUCATION AND HUMAN SERVICES

April, 2019

Signature Page

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Dedication

To my wife Sarah, and my parents Helen and Nicholas, whom without their constant love, support, and encouragement I could not have completed this program

Acknowledgement

I would like to acknowledge those who assisted me in completing this journey. First, I'd like to recognize all the members of my dissertation committee: Dr. Dinsmore, Dr. Livingston, Dr. Zoellner, and Dr. Ohlson. Your guidance has been invaluable in creating this document and jumpstarting my career as a researcher. Second, the faculty and staff of the Department of Clinical and Applied Movement Sciences in the Brooks College of Health for your support and patience while I complete this program. Lastly, my professional colleagues and friends who continually supported me through this process, I thank you.

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Abstract

This mixed-methods study investigated the effects of case method presentation on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students working through a musculoskeletal clinical problem. The study was framed by Marton and Säljö's levels of processing, McCrudden's et al. goal-focusing model, Cognitive Load Theory, and the Model of Domain Learning. Verbatim transcriptions for each problem-solving session was created and coded. Cohen's kappa was $\kappa = .75$ indicating substantial inter-rater reliability for the finalized coding schemes. Quantitative analysis included mean and standard deviation calculations followed by Mann Whitney-*U* comparisons which detected several significant differences between groups regarding clinical reasoning hypotheses generated, reasoning strategies implemented, and errors made during the problem-solving sessions. Moderate-to-large effect sizes, ranging from $r^2 = .64–.78$, indicated that differences in clinical reasoning between groups was mostly attributed to the case presentation method. Additionally, a qualitative profile enriched the data set by identifying differences in type of knowledge regulation each group exhibited and timing of treatment considerations. Specifically, participants in the simulated patient group were found to regulate more psychomotor skill knowledge compared to the written case study group who exhibited more regulation of propositional knowledge. This research project has already impacted the educational experiences physical therapy students receive in their professional education program. Future research should include multi-institutional investigations with a larger number of participants allowing for better representation of physical therapy students across professional education programs before generalizing any findings.

Chapter 1: Introduction

Physical therapy educators are charged with the responsibility of preparing students to meet the demands of the clinical environment. Physical Therapy is an autonomous health profession which means clinicians are accountable for their actions (Edwards, Jones, Carr, Braunack-Mayer, & Jensen, 2004a). This means physical therapy clinicians must take responsibility for the consequences of the clinical decisions they make with their clients. Clinical reasoning is the cognitive process physical therapy clinicians implement when making decisions regarding their client's care. Therefore, facilitating sound clinical reasoning skills in students needs to be a primary concern for professional education programs. As an educational leader I intend to guide my profession in identifying and implementing instructional strategies that best facilitate the acquisition of those necessary clinical skills that promote the best outcomes possible in clients seeking physical therapy services.

Physical Therapists are healthcare professionals who assist their clients, restore, and improve their overall physical functioning to enhance health, well-being, and quality of life (American Physical Therapy Association, 2014a). They practice in a variety of clinical settings including but not limited to hospitals, schools, and outpatient clinics. Clients seeking physical therapy services in an outpatient clinical setting will first undergo a thorough examination to determine those biological, social, and psychological factors contributing to their client's diminished level of functioning. Client's with contributing factors that are deemed outside the physical therapist's scope of practice are referred to the appropriate practitioner at that time. Contributing factors that fall within the physical therapist's scope of practice are treated accordingly. Of interest is the thinking and strategies Physical Therapists generate and implement when working with their clients in the outpatient clinical environment.

Clinical reasoning is a skill implemented by physical therapy clinicians when working with their clients. It has been characterized as a context-dependent process and in short is "the sum of the thinking and decision-making processes associated with clinical practice" (Higgs & Jones, 2008, p. 4). Regarding physical therapy, clinical reasoning has been conceptualized as a collaborative and hypothesis-oriented process situated in a biopsychosocial perspective of health (Jones, Jensen, & Edwards, 2008).

Clinical reasoning in physical therapy has been characterized as collaborative. Clients come to therapy with preconceived ideas and notions about their current health status and how it impacts their ability to actively participate in rehabilitation programs (Edwards, Jones, Higgs, Trede, & Jensen, 2004b; Jones et al., 2008). Three forms of collaborative reasoning have been identified– collaboration driven by the practitioner's cognition, collaboration in consideration of the client's cognitive contributions, and collaboration where new knowledge is created for both the clinician and client– each one allows the therapist and client to understand each other more wholly, affecting clinical decisions (Edwards et al., 2004b).

The clinical reasoning process is also hypothesis-oriented. Clinicians must be skillful in interpreting clinical data to develop impressions of possible factors contributing to their clients' current level of health and functioning. Subsequent data can support or refute those initial impressions. These impressions have been defined elsewhere as clinical reasoning hypotheses and may assist clinicians develop a better understanding of their client's movement dysfunction and drawing diagnostic conclusions (Gilliland & Wainwright, 2017; Jones et al., 2008).

In 2001, the World Health Organization published the *International Classification of Functioning, Disability, and Health* (ICF) model, a biopsychosocial approach to client management. This approach to client management requires healthcare professionals to attend to social and psychological factors that contribute to an individual's overall health in addition to present biological ones. The ICF model builds upon traditional healthcare biomedical models by being inclusive of individuals' contextual factors such as socioeconomic status and health risk factors (e.g., smoking and drug use). These contextual factors may affect how clients perceive their current health status contributing to their overall level of health. For example, the physical therapy management for a client who has undergone an acute total knee arthroplasty procedure may differ between a client who lives with a large family in a single-story dwelling compared to another client who lives alone in a multistory home. Therefore, it's important for physical therapy clinicians to attend to biological, psychological, and social factors influencing their clients' ability to fully participate in rehabilitation programs.

Previously, a physical therapy clinical reasoning strategies model was developed (Edwards et al., 2004a). This model highlighted several key clinical reasoning strategies experts implemented when working with their clients. They identified eight strategies and divided them among two broad headings– *diagnosis* and *management*. Diagnostic reasoning strategies were those that assisted clinicians draw diagnostic conclusions by considering those body function and structural impairments (*diagnostic* reasoning) along with their client's personal illness stories (*narrative reasoning*). Management reasoning strategies were those that assisted clinicians provide meaningful individualized care to their clients and are implemented throughout the entire episode of care (Christensen & Nordstrom, 2013). This research is focused on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when reaching a diagnostic conclusion and therefore made reasoning for *diagnosis* the focus for this study.

Clinical reasoning strategies assist clinicians compartmentalize their thinking and develop a rationale for the clinical decisions they make. Of interest is how the clinician accesses and organizes their knowledge when engaged in the clinical reasoning process. Jones et al. (2008) described this process as developing diagnostic hypotheses. They suggested that a fuller understanding of the hypothesis's clinicians generated and why may have implications for how clinical reasoning is taught in professional education programs. Previous work has described the clinical reasoning hypotheses manual physical therapists have when working with their clients (Jones, 1992). More recently, the diagnostic clinical reasoning hypotheses generated, and strategies implemented by physical therapy students when working through musculoskeletal clinical problems have also been described (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017).

Physical therapy educators implement multiple educational strategies when teaching their students including but not limited to lecture, small group work, peer learning, concept mapping, and case-methods (Jensen, Mostrom, & Shepard, 2013). Case-method teaching is an instructional strategy whereby students work through problems situated in a real-world context to stimulate thought and facilitate problem solving skills (Jensen et al., 2013). Regardless of case type and presentation method, case-method pedagogy has a well-established procedure–(a) preliminary information about the case is provided in advance to allow for reflection before beginning, followed by (b) group discussion on the case experience, and concluding with (c) reflection by students and educators on how the case-method experience has impacted their previously held beliefs, attitudes, and behaviors (McGinty, 2000).

One advantage of case-method teaching is the multitude of ways an educator can choose to present the clinical scenario to their students (McGinty, 2000). For instance, cases can be presented via written cases and simulated patients (McGinty, 2000). Written case studies are narrative case examples that provide a detailed description of a clinical scenario which often mirror actual prior client encounters (Rivett & Jones, 2008). Their advantages include that they are relatively cheap to produce, can be easily obtained from case reports published in the literature, and can be worked through on an individual or group basis, whereas their most notable disadvantages are the absence of social interaction that would normally take place between the student and their "client", and a lack of realism to the educational experience (Rivett & Jones, 2008). On the other hand, simulated patient cases overcome many of the disadvantages written case studies have. A simulated patient is an actor who is coached to portray a client with a specific case history and physical examination findings. When working through a clinical problem with an actor, the educational experience takes on a higher sense of realism by more closely resembling the interactions physical therapy students can expect to encounter during their clinical education experiences (Ladyshewsky, Baker, Jones, & Nelson, 2000). Furthermore, in addition to clinical reasoning skill acquisition, it has been suggested that case-method teaching presented via simulated patients may enhance other generic skills such as interviewing, counseling, and implementing physical therapy protocols (Rivett & Jones, 2008). Another advantage for using simulated patients is that clinical presentations can be standardized to ensure that each student participant is subjected to the exact same clinical scenario (Ladyshewsky et al., 2000; Rivett & Jones, 2008). However, the physical therapy educator must be careful that the actors "stick to the script" and do not vary in the way they provide information to students. Additionally, simulated patient actors need to be trained to accurately portray the clinical case scenario. Rivett and Jones (2008) identified that paid actors, the educators themselves, or even students can act as the simulated patients for clinical scenarios. Research on the use of simulated patients in the physical therapy classroom has been promising. For instance, physical therapy students that participated in a clinical role-play scenario had significantly greater improvements in both affective and cognitive domains regarding medical screening in a cardiopulmonary course compared to participants who received traditional lecture pedagogy (Boissonnault, Morgan, & Buelow, 2006).

Problem Statement

Clinical reasoning is a cognitive process used to make informed decisions about a client's episode of care. Those decisions directly affect outcomes ultimately impacting the client's quality of life. Therefore, it's essential that physical therapy students be educated how to implement sound clinical reasoning. Such an important construct should be well defined and have evidence for best educational practices. However recent evidence suggests otherwise. For instance, Christensen et al. (2017) found that despite all physical therapy education programs within the U.S. acknowledged including clinical reasoning within their curricula, 75% did not adopt a common definition of clinical reasoning within their respective programs. Furthermore, of the 25% that did adopt a standard definition, inconsistencies were identified among these programs regarding what constituted clinical reasoning in clinical practice. The Clinical Reasoning Curricula and Assessment Research Consortium of the American Council of Academic Physical Therapy is a recognized authority for setting standards of clinical reasoning research and education. Due to discrepancies identified between varied health professions and among its own membership, the Clinical Reasoning Curricula and Assessment Research Consortium identified the need for a common definition of clinical reasoning to refer to when performing research in this area. In 2012, they adopted the following as their operational definition of clinical reasoning:

> Clinical reasoning is a nonlinear, recursive cognitive process in which the clinician synthesizes information collaboratively with the patient, caregivers, and the health care team in the context of the task and the setting. The clinician reflectively integrates information with previous knowledge and best available evidence in order to take deliberate action. (Christensen et al., 2017, p. 117)

In addition to a lack of an operational definition for clinical reasoning at that time, the Clinical Reasoning Curricula and Assessment Research Consortium also felt there was a lack of evidence for best educational practices and assessment of clinical reasoning in physical therapy education. This claim has since been substantiated in the literature (Christensen et al., 2017). Therefore, it's imperative we become more knowledgeable of the impact varied educational practices have on the acquisition of clinical reasoning skills in physical therapy students. As discussed previously a fuller understanding of the diagnostic hypotheses generated, and strategies implemented by physical therapy students when working through clinical problems may have educational implications. This work has been initiated but is still in its infancy (Gilliland, 2017; Gilliland & Wainwright, 2017). Each of these studies have investigated the diagnostic clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when working through musculoskeletal clinical problems presented via simulated patient. Previously I described the advantages and disadvantages to using simulated patients as a format for case-method pedagogy in the classroom. However, written case reports are commonly used when implementing case-method teaching. At this time no research has investigated the effect of case-method pedagogy format on the diagnostic clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when reasoning through a musculoskeletal clinical problem.

Purpose Statement

The purpose of this study is to determine the effect of case-method teaching problem presentation (written case study versus simulated patients) on the–(a) clinical reasoning hypotheses generated, (b) clinical reasoning strategies implemented and (c) errors made by physical therapy students when reasoning through a musculoskeletal clinical problem.

Research Questions

Therefore, the main research questions for this study were as follows:

(a) *What effect does case method presentation have on the clinical reasoning hypotheses generated by physical therapy students when faced with a musculoskeletal clinical problem?*

(b) *What effect does case method presentation have on the clinical reasoning strategies implemented by physical therapy students when faced with a musculoskeletal clinical problem?*

(c) *What effect does case method presentation have on errors made by physical therapy students when faced with a musculoskeletal clinical problem?*

Each research question addresses the effect case-method presentation has on physical therapy student cognitive processes when engaged in clinical reasoning. I hypothesized that physical therapy students engaged in clinical reasoning when working through a musculoskeletal problem presented via written case study will generate a significantly greater number of clinical reasoning hypotheses and implement a significantly greater number of clinical reasoning strategies than physical therapy students clinically reasoning through the same musculoskeletal case presented via simulated patient format. This is because student participants assigned to the simulated patient group will have to physically perform several examination procedures that the written case study group will not. Regarding errors made, I hypothesized physical therapy students clinically reasoning through a musculoskeletal case presented via simulated patient format will have a significantly greater number of errors than those assigned to the written case study group. This is because participants assigned to the simulated patient group will have to cognitively consider the need for and perform those physical tests they deem necessary to obtain relevant clinical data from the case whereas participants assigned to the written case study group will not be burdened with this additional load on their cognition. Furthermore, I hypothesized that participants assigned to the simulated patient group will implement a significantly greater number of pattern recognition reasoning strategy. This is because student participants assigned to the simulated patient group may need to be more efficient in their time management needing to perform physical examination tests and measures that the written case study group will not.

Significance of the Study

As an educational leader my thoughts turn to the impact my work as an educator and researcher may have for my colleagues in physical therapy education and future students of physical therapy practice. Stephen Covey (2004) described that finding your voice and inspiring others to find theirs contributes to our excitement and passion for the work we do on a daily basis. Through this process I hoped to discover my voice as an educator, researcher, and healthcare professional for assisting other physical therapy educators, physical therapy students find their voices for providing outstanding physical therapy services to the communities they serve. For physical therapy educators this means providing new knowledge about the effect our pedagogical decisions have on their students learning and facilitating best practices in the classroom. For future students, I believe this research will assist in providing educational experiences that are learner-centered and effective. For instance, Robinson (2013) stated educational leaders should be considerate of three capabilities for promoting learner-centered education–(a) apply relevant knowledge, (b) solve complex problems, and (c) build trust. Through this research I hope to become more knowledgeable of best educational practices for promoting the development of clinical reasoning skill in my students, identify the best way to make those educational strategies feasible to implement in the academic setting, and earn the trust of my students.

Delimitations

The purpose of this study was to explore the similarities and differences between written case report and simulated patient as delivery formats for case-method pedagogy. First, this investigation was focused on the diagnostic clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when reasoning through a musculoskeletal clinical problem. Therefore, data collected during problem-solving scenarios were for this purpose. Additionally, this study was interested in the diagnostic clinical reasoning by students that have formally completed the musculoskeletal portions of their professional education programs. Therefore, only those students who have successfully completed the musculoskeletal component of their didactic education were considered for enrollment in this study. With respect to time and resource availability, participants for this research project were recruited from an accredited physical therapy professional education program located in northeast Florida.

Definition of Terms

- **Activity.** Involvement in functional movements at the level of the person (e.g., walking, and stair climbing).

- **Body function and structure.** Impairments identified at the level of the body (e.g., range of motion, and strength).
- **Biopsychosocial.** The integration of medical, social, and psychological frameworks of health to provide a holistic view of disability and health.
- **Clinical decision-making.** Conclusions drawn by a clinician for taking deliberate action and are typically the result of the clinical reasoning process.
- **Clinical education.** A component of physical therapy professional education whereby a physical therapy student works alongside a licensed physical therapist clinical instructor to facilitate learning through immersion in physical therapy practice.
- **Clinical reasoning.** A nonlinear, recursive cognitive process in which the clinician synthesizes information collaboratively with the patient, caregivers, and the health care team in the context of the task and the setting. The clinician reflectively integrates information with previous knowledge and best available evidence to take deliberate action.
- **Clinical reasoning hypotheses.** Thoughts and ideas for why a client is limited in their ability to perform functional activities and participate in meaningful life experiences.
- **Clinical reasoning strategies.** Organization of how to think and act in clinical practice.
- **Critical thinking.** A skill which attempts to develop understanding from a set of circumstances or context which can be applied to internalized thinking or the thinking of others.
- **Diagnostic conclusion.** A formal decision that has been made by a clinician regarding the underlying reason for the presence of body functioning and structure impairments, as well as the activity and participation limitations experienced by their client.

- **Diagnostic reasoning.** The formation of a diagnosis related to physical disability and impairments with consideration of biological factors.
- **Episode of care.** The ongoing process of physical therapy management initiated at the point of first contact and persisting through the point of final contact with a client
- **Hypothetico-deductive reasoning.** A deductive reasoning strategy whereby a clinician collects initial data, generates an initial list of potential problems that could be causing the patients symptoms and performs tests that will assist in supporting or refuting each identified potential problem.
- **Narrative reasoning.** The formation of a diagnosis related to the understanding and appreciation for client stories, illness experience, beliefs, and culture.
- **Participation.** Involvement in functional activities at the level of society (e.g., working in an office with stairs)
- **Pattern recognition.** A reasoning strategy where clinicians identify key features of a case to promptly come to a conclusive diagnosis and is typically implemented by expert clinicians.
- **Physical Therapy.** A healthcare profession with established theoretical and scientific base and extensive clinical application for the restoration, prevention, and promotion of optimal physical functioning.
- **Physical Therapist.** A healthcare professional who assists members of society maintain, restore, and improve their overall physical functioning for enhancing health, well-being, and quality of life.
- **Reasoning for diagnosis.** Integration of diagnostic and narrative reasoning strategies for reaching a diagnostic conclusion.

- **Physical therapy student.** An individual enrolled in a physical therapy professional education program of study.

Chapter 2: Literature Review

Leaders in physical therapy education should be knowledgeable of contemporary best-educational practices, how students learn, and how instructional methods influences student learning. As a precursor for the delivery of effective health care and a fuller understanding of best educational practices for facilitating the development of physical therapy student clinical reasoning, an investigation of the following research question was warranted–W*hat effect does case method presentation have on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when faced with a musculoskeletal clinical problem?*

Clinical reasoning has been described as a complex phenomenon implemented by healthcare professionals to assist in making sound clinical decisions incorporating clinician-centric discipline specific knowledge, cognition, and metacognition that has been expanded to include societal contextual factors such as the individualized needs of the client, third party payer guidelines, and the needs of health care organizations (Higgs & Jones, 2008). However, the Clinical Reasoning Curricula and Assessment Research Consortium of the American Council of Academic Physical Therapy recently determined that many opinions exist concerning how to define and what constitutes the clinical reasoning process across healthcare professions as well as within the physical therapy profession itself. As a result, they adopted an operational definition for researchers of clinical reasoning in physical therapy (Christensen et al., 2017). Before this, researchers developed their own definitions which shaped contemporary beliefs of what clinical reasoning is and its constituents in physical therapy practice. As I examined the literature, I was cognizant of how each researcher chose to define clinical reasoning and how the results of their studies led to our current understanding of what constitutes the clinical reasoning process in clinical practice.

One purpose of this study is to explore best educational practices for teaching clinical reasoning to students. Jensen et al. (2013) identified several instructional methods physical therapy educators implement in the academic environment including but not limited to lecture, small group work, peer learning, concept mapping, and case-methods. Therefore, physical therapy educators have a multitude of options for facilitating clinical reasoning skill acquisition in their students. Therefore, I propose my literature review should be inclusive of how clinical reasoning has been taught in physical therapy professional education.

In addition to best educational practices, educators should provide educational experiences that are both effective and positively regarded by their students. Ideally, the most effective instructional strategy for teaching clinical reasoning would mirror student preferences for how they be educated. With so many instructional strategies, it is prudent to ascertain those methods that physical therapy students have the highest affinity for. Therefore, investigating educational strategies students identified most positively for facilitating their clinical reasoning skill development was warranted.

To develop a thorough understanding of the literature, as it currently exists regarding answering my main research question, I propose four guiding questions. I believe answering these guiding questions will best inform what still needs to be learned in answering my main research questions. The four guiding questions that I propose to shape my literature review are as follows:

a. How have researchers defined clinical reasoning in physical therapy?
b. What constitutes the clinical reasoning process for physical therapy?

c. How is clinical reasoning taught in physical therapy professional education?
d. What are physical therapy student perceptions of clinical reasoning in professional education?

I believe investigating these four questions is necessary for a thorough understanding for what clinical reasoning is, how it's taught, and what still needs to be known about it. Examining the first two guiding questions highlighted those factors present when physical therapy students engage in clinical reasoning. This informed the finalized coding scheme for this research project. Guiding questions (c) and (d) assisted in identifying those instructional strategies that have been found to be both effective and positively regarded by physical therapy students. Therefore, researching these specific guiding questions informed the methodology of this research by highlighting those instructional strategies that warrant further investigation.

As stated previously only recently has an operational definition of clinical reasoning for researchers in physical therapy been adopted. This definition outlines many variables that should be considered by researchers when investigating the phenomenon of clinical reasoning including the internalized thoughts and strategies implemented by physical therapy clinicians when engaged in the clinical reasoning process. Continued research may further expand our conceptualization of what constitutes the clinical reasoning process in physical therapy and how we define it.

For these reasons, a richer understanding for how instructional strategies influences student cognitive processes when engaged in clinical reasoning is needed. This knowledge may assist physical therapy educators choose the most effective instructional strategies that facilitate learning skills their students need to exhibit sound clinical reasoning when working with clients during clinical education experiences.

Methods

Search strategy. Several electronic databases were utilized to locate relevant literature for this systematic review: PubMed, CINAHL, ERIC, and Cochrane database. In addition, Google Scholar was utilized to capture any further articles not discovered in the database searches. The key terms clinical reasoning, clinical decision-making and critical thinking have all been used interchangeably in literature (Christensen et al., 2017; Furze et al., 2015). Therefore, the systematic search was conducted in consideration of these key terms.

The PubMed search began by using the Medical Subject Heading (MeSH) physical therapy specialty as a major heading. Medical Subject Headings are a way of regulating the vast biomedical vocabulary that exists. On an annual basis MeSH terms are either newly created or updated to match current trends in medical terminology. When using a MeSH term as a major heading in a literature search on the PubMed database the search results provide only those articles in which the MeSH major heading was at least one of the main topics of that article. The PubMed search was refined with the major MeSH headings of clinical decision making, and thinking (which includes critical thinking), as well as the key word clinical reasoning (which does not have a MeSH heading in the PubMed database). Therefore, the search in the PubMed database took on the following form: “Physical Therapy Specialty” [Majr] AND ((“Clinical Decision-Making” [Majr]) OR (“Thinking” [Majr]) OR “clinical reasoning”). This search was further refined to include articles published since the year 2000 and returned a total of 108 articles for review.

The second database searched for this literature review was CINAHL. Like the PubMed database, CINAHL provides their own headings for ensuring articles retrieved by the database have those selected headings as a main topic. In keeping the search terms consistent across databases, the headings of physical therapy, clinical reasoning, clinical decision making, and critical thinking were inputted. However, the term clinical reasoning did not have a major heading in the CINAHL database either. Furthermore, the CINAHL database separates the term physical therapy between multiple major headings. The major headings of "Students, Physical Therapy" and "Education, Physical Therapy" were selected for their relevance in conducting the systematic review. Therefore, the search in CINAHL 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")). This search was refined to include articles published since the year 2000and returned a total of 276 articles for review.

Similar search terms were used to locate relevant literature in ERIC, Cochrane database, and Google Scholar. A search of the ERIC database returned 22 articles for review and the Cochrane database search returned 39 articles. Google Scholar was utilized to identify any further articles that the previous databases did not capture. Key terms were entered, and the results sorted by relevance. Search results in Google Scholar continued until a saturation effect was perceived; when no new articles were set aside for consideration for inclusion in this review after 50 continuous returns. This strategy added two further articles for consideration for inclusion into the finalized literature review.

Inclusion and exclusion criteria. For articles to be included in the final review the following criteria were used: (a) provided evidence or theory regarding contemporary beliefs of the constituents of clinical reasoning in the physical therapy profession, (b) provided empirical evidence (qualitative, quantitative, or mixed methods) addressing how clinical reasoning is taught in professional education, (c) provided empirical evidence for how physical therapy students perceive clinical reasoning in the profession and/or professional education, and (d) were specific to diagnostic clinical reasoning. Exclusion criteria included any publications printed before the year 2000 and research addressing clinical reasoning education in post-professional education programs or graduated physical therapists only while not informing the constituents of clinical reasoning in physical therapy. For example, Edwards et al. (2004a) was included in the final review although their findings were based on practice patterns of “expert” physical therapists because of its significance informing the constituents of clinical reasoning in the physical therapy profession, one of the primary purposes of this review. Further exclusion criteria included empirical studies whose primary purpose was to describe moral/ethical reasoning or reasoning in a specialty area other than orthopaedics/musculoskeletal physical therapy. For example, Kenyon (2013) was excluded because it provided a clinical reasoning framework exclusively for pediatric physical therapy, a specialty area of physical therapy practice not under consideration in this review. After applying the inclusion/exclusion criteria 37 studies were included in the final literature review and 409 were excluded (Figure 2.1).

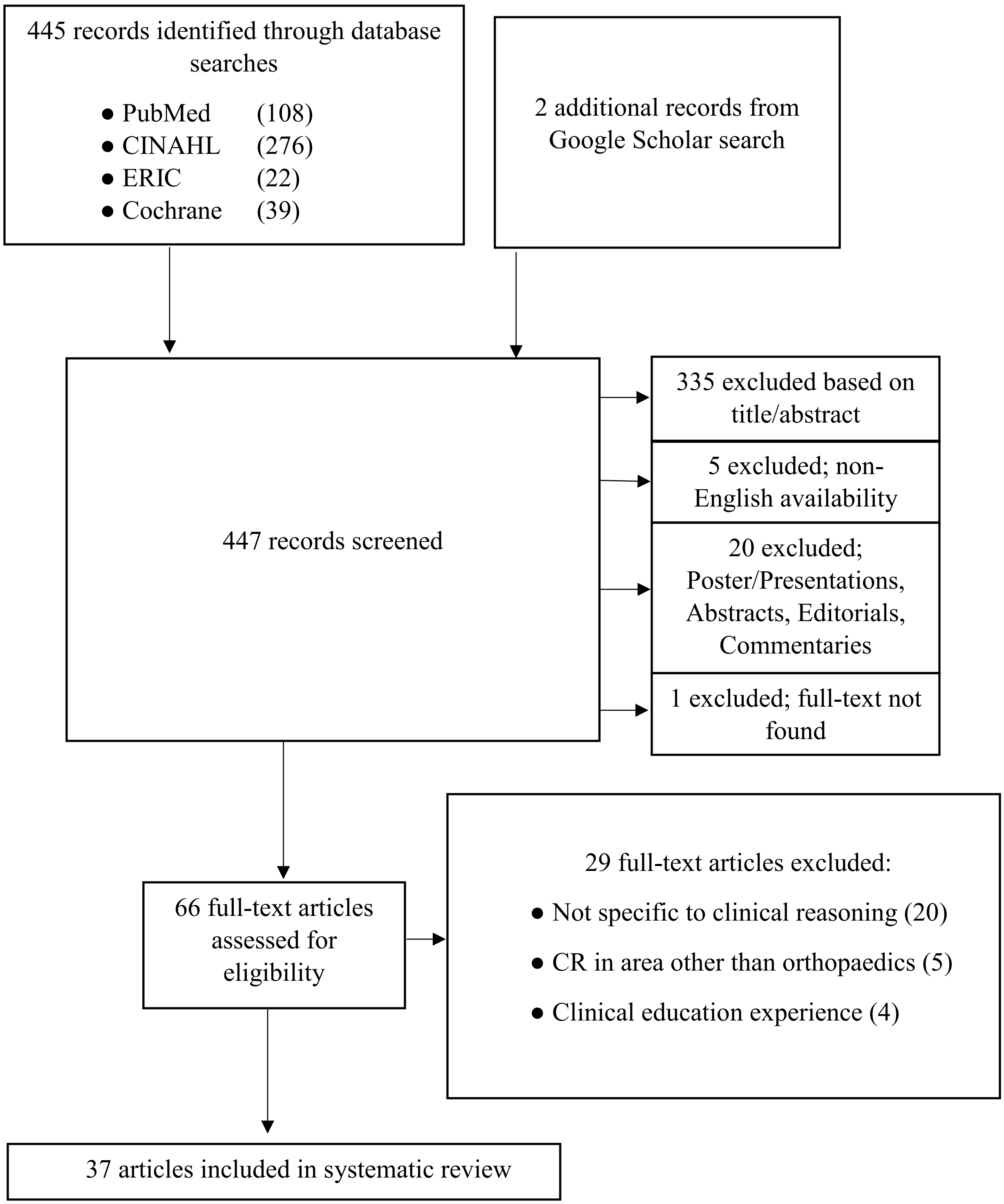

Figure 2.1. PRISMA flow summarizing the systematic review process

Table coding. The following sections provide the results and discussion points of the literature examined from this systematic review. All included citations have been tabled (Table 2.1) and organized into six columns. The left most column provides a collapsed citation of the referred article. All referred articles were listed chronological starting with the most recent. For referred articles within the same publication year, citations were listed alphabetically by surname. Information regarding participants for empirical studies were provided in the second column. The remaining four columns informs how each referred article informs–(a) how clinical reasoning was defined, (b) the constituents of clinical reasoning, (c) instructional methods for clinical reasoning, and (d) student perceptions of clinical reasoning, from left to right (a–d). For instance, Baker et al. (2017) informs three of the four main goals for this systematic review (a, b, and c). This information can be found under their respective columns. Sections of the table were left blank when the referred article did not inform that column. For instance, Baker et al. (2017) does not inform how physical therapy students perceived the clinical reasoning process and therefore the rightmost column (d) of the table remained blank.

Table 2.1

Clinical Reasoning in Physical Therapy

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Baker et al. (2017)	Orthopaedic manual Physical Therapist (*n* = 1)	Decision making process comprising analytical & narrative thinking	SCRIPT emphasizes hypothetico-deductive reasoning	Instructor gleaned insight into the CR of their protégé	
Christensen et al. (2017)	Accredited physical therapy education programs (*n* = 96)			Clinical reasoning taught via multiple methods & frameworks	
Gilliland (2017)	Students at the beginning of their second, and end of their fourth and fifth semesters (*n* = 6)	Complex problem framing, solving, & decision-making process	Progression seen from simple hypothesis & strategies to ones identified in experts		
Gilliland & Wainwright (2017)	Second year students from two universities (*n* = 8)	Problem-framing, solving, & decision-making process	Multiple hypotheses & strategies implemented		
Huhn (2017)	First year Doctor of Physical Therapy students (*n* = 60)	Nonlinear, recursive process; data created collaboratively in context of task & setting		Use of metacognition increased after a critical reasoning course	

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Miller et al. (2017)	Three consecutive cohorts of second year students (*n* = 54, 54, 55)			Increased scores for CR, screen., exam., & eval. during clinical education	Increased confidence entering clinical education experiences
Elvén et al. (2015)	Sixth semester students (*n* = 10); Behavioral expert physical therapists (*n* = 9)	Capability needed to create & examine interventions & their effectiveness	Consideration for factors impacting a client's willingness for behavioral change		
Furze et al. (2015)	Doctoral students at Creighton University (*n* = 98)	Thought process & judgment behind one's actions	Three stages: beginner, intermediate, & entry-level		Reasoning perceived from therapist centric initially to collaborative
Øberg et al. (2015)		Judgements made before, during, and after clinical sessions inclusive of a philosophical conception of the body as subjective	Required understanding of the client as a lived-body & is an intersubjective process		

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Caeiro et al. (2014)	Fourth year undergraduate students (*n* = 18)			Inclusion of arts, literature, & reflective writing enhanced narrative reasoning skills	Developed empathy, self-awareness, & reflection in practice
Cruz et al. (2014)	Final year undergraduate students (*n* = 28)			Many student attributes enhanced	An instrumental process, therapist-centric, & context dependent
Gilliland (2014)	First and third year students (n = 6,6)	Precursor to clinical decisions & actions	Hypotheses & strategies implemented ranged from novel to expert		
Keiller & Hanekom (2014)	Two consecutive cohorts (*n* = 14, 24)			No differences in CT or CR skill after a hybrid-problem based learning course	
Maas et al. (2014)	Second year undergraduate students (*n* = 12)				Performing as therapist was most valuable to learning

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Boucher et al. (2013)	Four consecutive student cohorts			Flipped classroom allowed for more student-centered instruction	
Huhn et al. (2013)	Doctor of physical therapy students (*n* = 53)			No quantitative differences between groups; More high-level reasoning in virtual group identified qualitatively	
Rowe et al. (2013)	Second year students (*n* = 12)			Increased collaboration among students & educators	Perceptions of learning from teacher centered to self-driven
Seif et al. (2013)	Musculoskeletal series Pretest (*n* = 63); Posttest (*n* = 55)	Decision-making process regulating appropriate tests and measures, and procedural interventions		Significant increases on SACRR items	
Cruz et al. (2012)	Final year undergraduate students (*n* = 28)				An instrumental process, therapist-centric, & context dependent

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Rowe (2012)	Third- & fourth-year students (*n* = 70)				Social networks enhanced practice knowledge & self-reflection
Atkinson & Nixon-Cave (2011)	Therapist in a post-professional pediatric residency program (*n* = 1)	Applying cognitive & psychomotor skills to direct client situations	PT-CRT tool for facilitating reasoning strategies & reflection	Reasoning skill acquisition through enhanced dialogue between mentors and protégés	
Huhn & Deutsch (2011)	Faculty & students in a usability analysis (n = 5,5); students in feasibility, & pilot study (*n* = 45, 36)	Combining clinical context with previous experience impacting clinical decisions		No significant differences in HSRT scores	
Loghmani et al. (2011)	Doctoral students Time 1 (*n* = 99); Time 2 (*n* = 69)				ILCBL model perceived positively for developing CDM, CT, & problem solving
Snodgrass (2011)	Third year undergraduate students (*n* = 58)	Problem-solving skill including knowledge, reflection, & metacognition			Web-based wikis perceived less valuable than in-class sessions

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Babyar et al. (2010)	Students completing a final clinical education experience (*n* = 91)	Cognitive decision making used in evaluation & management			Demonstrations assisted in developing CR skills in MSK courses
Hendrick et al. (2009)	Second- & third-year students (*n* = 31)	Health practitioner thinking & decision-making			Reasoning from therapist centric to client-focused; Self-confidence increases over time
Roche & Coote (2008)	Third- & fourth-year students (*n* = 10,10)				Reflection module promoted client centered practice
James (2007)	Students (*n* = 9); Experts (*n* = 6)	Use of propositional, heuristic & tactic knowledge	Three tiers of reasoning identified		
Darrah et al. (2006)	Students from four separate integrated practice courses	Abstract thought processes & strategies leading to a clinical decision	Decision-making emphasizes collaboration & client values	The COR_xE implemented during case method instruction	

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Ward & Gracey (2006)	Professional practice coordinators (*n* = 33)			No definitive instructional method identified to facilitating reflective practice	
Edwards et al. (2004a)	Two groups of expert physical therapists (*n* = 6,6)	Thinking & decision-making processes used in clinical practice	Eight diagnosis & management strategies identified		
Ladyshewsky (2004)	Individual & dyad simulated patient (*n* = 6,6)	Collaborative decision-making process structuring meaning, goals, & management strategies	Students implement varied reasoning strategies & hypotheses during simulated patient encounters	Dyad groups produce more reasoning hypotheses & more likely to discuss contextual factors of a case	
Babyar et al. (2003)	Students from 14 physical therapy education programs (*n* = 156)	Cognition & thinking used in client evaluation & management			Case-method teaching preferred for learning CR
Rothstein et al. (2003)			Hypothetico-deductive reasoning as outlined in the HOAC II model		

Table 2.1 (continued)

Citation	Participants	Definition	Constituents	Instruction	Student Perceptions
Doody & McAteer (2002)	Expert therapists, third- & fourth-year students (*n* = 10,5,5)	Thinking & decision-making process about a client's examination & management	Students exhibited hypothetico-deductive reasoning whereas experts also exhibited pattern recognition		
Gillardon & Zipp (2002)	Two consecutive cohorts enrolled in a Physical Therapy education program			Student groups facilitated through the HOAC model by educators	Case-method teaching facilitated hypothetico-deductive reasoning
Ladyshewsky (2002)	Students assigned to independent & dyad groups (*n* = 20, 42)	Thinking & decision-making associated with clinical practice		Dyads scored higher in history, objective examination, communication, & CR skills	

Note. CR = clinical reasoning; CT = critical thinking; CDM = clinical decision making; MSK = musculoskeletal; SCRIPT = systematic clinical reasoning in physical therapy; PT-CRT = physical therapy clinical reasoning and reflection tool; ILCBL = integrated longitudinal case-based learning; SACRR = self-assessment of clinical reflection and reasoning; HSRT = Health Science Reasoning Test; HOAC = Hypothesis-Oriented Algorithm for Clinicians

Results and Discussion

The following sections detail the results and discussion points of the systematic review regarding clinical reasoning in physical therapy. A total of 37 articles were included in the final review. From these a total of 19 were qualitative studies, 5 quantitative, 11 mixed-methods, and 2 theoretical/non-empirical. Both non-empirical studies included provided theoretical perspectives on the constituents of clinical reasoning and therefore met inclusion criteria for this review (Øberg, Normann, & Gallagher, 2015; Rothstein, Echternach, & Riddle, 2003).

Defining clinical reasoning. A total of 21 out of the 36 included articles in this literature review provided an explicit definition for clinical reasoning. The Clinical Reasoning Curricula and Assessment Research Consortium has defined clinical reasoning as a collaborative, recursive, cognitive process which requires clinicians to reflect upon their previous experiences and combine them with best current evidence to take action (Christensen et al., 2017). This definition of clinical reasoning implies the clinical reasoning process requires thinking or cognition from the clinician, clients or other stakeholders should be included in the process; it should be cyclic in nature, and inclusive of reflection and for action. Therefore, these main themes were considered in synthesizing the literature for how clinical reasoning was defined (i.e., thinking/cognition, collaboration, reflection, recursion, for action).

The most referenced theme of the Clinical Reasoning Curricula and Assessment Research Consortium's definition from the systematic review was cognition on the clinician's part. All 21 articles explicitly stated or inferred clinical reasoning is a cognitive process. For instance, Furze et al. (2015) defined clinical reasoning as a process that requires thought and judgement to justify the actions a clinician takes with their client. In another example, Doody and McAteer (2002) partly defined clinical reasoning as a thinking and decision-making process.

A total of 18 articles defined clinical reasoning as a process for taking-action making it the second most referenced theme from the Clinical Reasoning Curricula and Assessment Research Consortium's definition detected from the systematic review (Atkinson & Nixon-Cave, 2011; Babyar, Pivko, & Rosen, 2010; Babyar et al., 2003; Baker et al., 2017; Darrah, Loomis, Manns, Norton, & May, 2006; Doody & McAteer, 2002; Edwards et al., 2004a; Elvén, Hochwälder, Dean, & Söderlund, 2015; Furze et al., 2015; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; Hendrick, Bond, Duncan, & Hale, 2009; Huhn & Deutsch, 2011; Ladyshewsky, 2002, 2004; Seif, Brown, & Annan-Coultas, 2013; Snodgrass, 2011). For example, Elvén et al. (2015) defined clinical reasoning as a process the physical therapist performs to drive decisions regarding procedural intervention selection and determining their effectiveness, and Seif et al. (2013) defined it as a process used for determining appropriate tests and measures to perform and selecting procedural interventions to implement when working with clients. These examples exemplify clinical reasoning as a psychomotor process in addition to a cognitive one. Atkinson and Nixon-Cave (2011) stated this best when they partly defined clinical reasoning as the application of cognitive and psychomotor skills.

Four studies were inclusive of reflective inquiry and metacognition in their definitions of clinical reasoning (Atkinson & Nixon-Cave, 2011; Huhn & Deutsch, 2011; Øberg et al., 2015; Snodgrass, 2011). For example, Øberg et al. (2015) implied the presence of reflection-in-action, reflection-on-action, and reflection-for-action when they defined clinical reasoning as judgements made before, during, and after clinical sessions, whereas Snodgrass (2011) defined clinical reasoning as a problem-solving skill inclusive of reflective inquiry.

Only, two studies were inclusive of collaboration in their definition of clinical reasoning (Huhn, 2017; Ladyshewsky, 2004). Lastly, two studies defined clinical reasoning as a recursive process (Huhn, 2017; Huhn & Deutsch, 2011). For example, Huhn (2017) partly defined clinical reasoning as a non-linear recursive process and Huhn and Deutsch (2011) defined clinical reasoning as a process where the clinician synthesizes information with previous experiences. These examples highlight clinical reasoning as a recursive process requiring physical therapists to weigh the value of new clinical experiences against previously held knowledge and beliefs when making clinical decisions.

Clinical reasoning definitions. Regarding studies from the systematic review that provided an explicit definition of clinical reasoning, all of them were inclusive of thinking or cognition on the clinician's part. When the terms cognition or thinking were not explicitly included in definitions of clinical reasoning, their presence was implied. Some example definitions that implied the presence of cognition/thinking in clinical reasoning included: (a) a complex framing, solving and decision-making process, (b) the capability needed to synthesize information, and (c) a decision-making process used to regulate appropriate clinical actions (Elvén et al., 2015; Gilliland, 2017; Gilliland & Wainwright, 2017; Seif et al., 2013). For instance, synthesizing information is a skill that requires thinking to perform effectively. Therefore, when teaching students, it is important to understand their internalized thoughts and how they organize them so that educators can implement instructional strategies best tailored to facilitate sound thinking and cognition capability.

The second most defined characteristic of clinical reasoning as identified by the Clinical Reasoning Curricula and Assessment Research Consortium was reasoning for taking-action. Of these studies most of them (13/18) defined clinical reasoning as a skill that assists in decision making (Babyar et al., 2010; Baker et al., 2017; Darrah et al., 2006; Doody & McAteer, 2002; Edwards et al., 2004a; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; Hendrick et al., 2009; Huhn & Deutsch, 2011; Ladyshewsky, 2002, 2004; Seif et al., 2013). Some of these studies defined clinical reasoning as a process that leads to clinical actions/decisions but did not specify what they are nor who they are directed to (Atkinson & Nixon-Cave, 2011; Darrah et al., 2006; Edwards et al., 2004a; Ladyshewsky, 2002). This is interesting because physical therapists are responsible to multiple stakeholders when providing rehabilitation services to clients. First, sound clinical reasoning should result in the best outcomes for clients from the physical therapy services they receive. Additionally, physical therapy clinicians have responsibilities to the organizations they work for, third-party payor organizations, and other healthcare professionals involved in their client's care. Therefore, the clinical decisions physical therapists make often have implications that reach beyond the client and affect much larger sociopolitical environments which may have future research implications.

A further ten studies defined clinical reasoning as a process performed for directing the client's examination or management (Atkinson & Nixon-Cave, 2011; Babyar et al., 2010; Babyar et al., 2003; Doody & McAteer, 2002; Edwards et al., 2004a; Elvén et al., 2015; Huhn & Deutsch, 2011; Ladyshewsky, 2002, 2004; Seif et al., 2013). For example, Babyar et al. (2010) defined clinical reasoning as a cognitive decision-making process used in client evaluation and management, and Elvén et al. (2015) defined it as the capability needed to synthesize and analyze information to tailor interventions and evaluate their effectiveness. Therefore, physical therapy educators should continue to focus on providing educational experiences that develop clinical reasoning capability that is inclusive of contextual factors for their students.

Defining clinical reasoning as a recursive, collaborative, and reflective process has been happening. For instance, only one study published before 2010 in this review included any of these concepts in their definition of clinical reasoning (Ladyshewsky, 2004). In that study, clinical reasoning was partly defined as a practice inclusive of collaboration with the client for developing a comprehensive care plan. All other definitions inclusive of recursion, collaboration, or reflection have been published this decade (Atkinson & Nixon-Cave, 2011; Huhn, 2017; Huhn & Deutsch, 2011; Øberg et al., 2015; Snodgrass, 2011). This is interesting because how clinical reasoning is defined has seemingly transformed from simplistic thinking for taking-action to a more sophisticated process inclusive of collaboration and metacognition concurring with the Clinical Reasoning Curricula and Assessment Research Consortium's contemporary definition. Future research should explore these as well as other tenants of clinical reasoning not expressed in contemporary definitions of clinical reasoning.

Constituents of clinical reasoning. A total of 14 studies informed those elements that constitute the physical therapy clinical reasoning process. As stated previously, clinical reasoning is comprised of those strategies implemented and hypotheses generated by clinicians when working with their clients (Jones et al., 2008). This section will describe the clinical reasoning strategies and hypotheses identified in this systematic review.

Clinical reasoning strategies have been defined as how healthcare professionals organize their thoughts and actions in the clinical environment (Edwards et al., 2004a). This research described two primary clinical reasoning strategies healthcare professionals implement when working with their clients– hypothetico-deductive reasoning and pattern recognition. A total of 11 studies described hypothetico-deductive reasoning or pattern recognition as strategies physical therapists implemented when engaged in the clinical reasoning process (Atkinson & Nixon-Cave, 2011; Baker et al., 2017; Darrah et al., 2006; Doody & McAteer, 2002; Edwards et al., 2004a; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; James, 2007; Ladyshewsky, 2004; Rothstein et al., 2003). Of these studies, all 11 proposed that clinical reasoning in physical therapy practice is comprised of hypothetico-deductive reasoning. Hypothetico-deductive reasoning is a reasoning strategy whereby a clinician collects initial data, generates an initial list of potential problems that could be causing their client's symptoms, and performs tests and measures that will assist in supporting or refuting each identified potential problem (Rothstein & Echternach, 1986; Rothstein et al., 2003). For instance, Baker et al. (2017) highlighted hypothetico-deductive reasoning strategy when they stated physical therapy clinicians should support their clinical decisions with those key objective and subjective features identified during a client examination. Hypothetico-deductive reasoning has also been identified in physical therapy students during their clinical reasoning of musculoskeletal clinical problems (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; Ladyshewsky, 2004). Five out of the 11 studies identified pattern recognition as a clinical reasoning strategy implemented by physical therapists (Atkinson & Nixon-Cave, 2011; Doody & McAteer, 2002; Edwards et al., 2004a; Gilliland, 2014; Huhn, McGinnis, Wainwright, & Deutsch, 2013). This strategy requires clinicians to quickly identify key features of a case to promptly arrive at a diagnostic conclusion and has been regarded as a strategy implemented mostly by expert clinicians (Doody & McAteer, 2002; Edwards et al., 2004a). However, other studies found that physical therapy students also implement *expert* pattern recognition strategy when reasoning through clinical problems in their professional education programs (Gilliland, 2014; Huhn et al., 2013).

Clinical reasoning strategies other than hypothetico-deductive reasoning and pattern recognition were also identified in this systematic review. A total of nine studies further informed us of those clinical reasoning strategies physical therapists implement when working with their clients (Baker et al., 2017; Darrah et al., 2006; Edwards et al., 2004a; Elvén et al., 2015; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; James, 2007; Øberg et al., 2015).

For instance, Edwards et al. (2004a) described a total of eight clinical reasoning strategies implemented by expert physical therapists. These strategies were organized into two major headings– diagnosis and management. Two studies described strategies attentive of objective clinical findings (Baker et al., 2017; James, 2007). However, multiple studies described clinical reasoning strategies focused on psychosocial factors such as the client's personal lived experiences (i.e. narrative reasoning), their willingness to make necessary behavioral changes, and the need for consideration of the client as a lived subjective body (Darrah et al., 2006; Edwards et al., 2004a; Elvén et al., 2015; Øberg et al., 2015). Lastly, five studies informed those clinical reasoning strategies students implemented when reasoning through clinical problems during their professional education. These strategies included but are not limited to: trial and error, following protocol, reasoning about pain, rule in/out, and reasoning of causal factors (Doody & McAteer, 2002; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; James, 2007).

As stated previously an understanding of the internalized thoughts made and how they are organized to implement clinical reasoning strategies may have implications on how clinical reasoning is taught in professional education programs (Jones et al., 2008). Clinical reasoning hypothesis categories have been defined as the thoughts and ideas physical therapy clinicians have for why a client is unable to perform functional activities and participate in meaningful life experiences (Gilliland, 2017). This systematic review identified six studies that informed hypothesis categories implemented by physical therapist and students (Baker et al., 2017; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; James, 2007; Ladyshewsky, 2004). For instance, James (2007) identified several knowledge sources that constitute clinical reasoning hypotheses such as joint patterns and muscle patterns. In another example, Baker et al. (2017) described symptom severity as a clinical reasoning hypothesis that may influence how the physical therapy practitioner would carry out a physical examination of their client. With respect to physical therapy students, a total of six studies informed the clinical reasoning hypotheses they generated when working through clinical problems (Doody & McAteer, 2002; Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; James, 2007; Ladyshewsky, 2004). Many of those hypothesis categories were considerate of objective factors such as anatomical structure, health conditions, mechanisms of injury, and body functioning/impairments, while others considered contextual factors such as patient impact and psychosocial inquiry (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; James, 2007; Ladyshewsky, 2004).

In addition to substantiating those strategies implemented and hypotheses generated while engaged in the clinical reasoning process, research has also explored the presence of other tenants of clinical reasoning for diagnosis including– collaboration and reflection. For instance, collaboration between the physical therapist and their client's internal contexts are at the center of the COR_xE clinical decision-making model and is one of eight recognized clinical reasoning strategies implemented by expert physical therapy clinicians (Darrah et al., 2006; Edwards et al., 2004a). In another example, Atkinson and Nixon-Cave (2011) included reflection as a constituent of clinical reasoning in physical therapy in their Physical Therapy Clinical Reasoning and Reflection Tool. The presence of reflection has also been observed in the clinical reasoning of physical therapy students (Gilliland & Wainwright, 2017).

Clinical reasoning strategies and hypothesis categories. Clinical reasoning in physical therapy has been characterized as a series of specific hypothesis and strategy categories that physical therapists generate and implement when working with their clients. Conceptualized as a two-tiered system, clinical reasoning hypotheses are the internalized thoughts and ideas of the physical therapist whereas clinical reasoning strategies are how they organize their clinical reasoning hypotheses to take-action. For instance, James (2007) described a blackboard model of clinical reasoning in physical therapy. He identified several clinical reasoning hypotheses physical therapy experts and students generate when working through a clinical problem. His blackboard model of clinical reasoning included three strategy levels– symptom, picture, and pattern. He recognized a therapist who considered only a single clinical reasoning hypothesis to be implementing symptom level strategy, but when they considered at least two hypotheses simultaneously they were said to be executing picture or pattern level strategy. He further identified that while experts demonstrated clinical reasoning strategies at the picture and pattern level of his blackboard model of reasoning, students only functioned on the lowest symptom level. These findings were contradicted when it was discovered that physical therapy students combine several hypothesis categories to engage in the reasoning strategy of reasoning about pain (Gilliland, 2017). Similarly, pattern recognition was a clinical reasoning strategy previously believed to be reserved for expert therapists (Edwards et al., 2004a). However, recent evidence has identified that some students implement at least a rudimentary level of pattern recognition strategy when working through musculoskeletal clinical problems (Gilliland, 2014). Other studies reported that physical therapy students demonstrate clinical reasoning strategies inclusive of client contextual factors (Furze et al., 2015; Hendrick et al., 2009). This is interesting because the consideration of client contextual factors in the rehabilitation process has been previously regarded as an ability that differentiated *novice* level therapists from *expert* clinicians (Jensen, Gwyer, Shepard, & Hack, 2000; Jensen, Shepard, Gwyer, & Hack, 1992). Research should continue to investigate physical therapy students clinical reasoning ability to further our understanding of their potential for clinical reasoning skill acquisition during their professional education programs. This knowledge could impact future curriculum designs that are tailored to meet the needs of both future students and our society at large. For instance, enhanced case-method teaching policies in professional education programs may facilitate more sound clinical reasoning capability in new graduates which may impact the clinical outcomes of their clients while reducing overall healthcare spending.

Pedagogy of clinical reasoning in physical therapy education. This systematic review identified 19 studies detailing how clinical reasoning is taught in physical therapy education. After reviewing the literature four main themes were identified. The first theme was the use of protocols/frameworks (Atkinson & Nixon-Cave, 2011; Baker et al., 2017; Christensen & Nordstrom, 2013; Darrah et al., 2006; Gillardon & Zipp, 2002). For example, the Systematic Clinical Reasoning in Physical Therapy (SCRIPT) and the Physical Therapy Clinical Reasoning and Reflection (PT-CRT) tools are frameworks that allow mentors to "visualize" the clinical reasoning of their protégés (Atkinson & Nixon-Cave, 2011; Baker et al., 2017). These tools are designed to assist physical therapy clinician's in their professional development and continued learning; however, these frameworks have not been empirically researched in the student population at this time. In another example, Gillardon and Zipp (2002) described how they incorporated the Hypothesis-Oriented Algorithm for Clinicians in the classroom with their students. Additionally, 93.8% of accredited physical therapy programs in the U.S. implement the APTA's Patient/Client model protocol as outlined in the *Guide to Physical Therapist Practice* and another 93.8% use the *International Classification of Functioning, Disability, and Health* protocol to teach clinical reasoning (Christensen et al., 2017).

Second, six studies described the inclusion of technology in the classroom for facilitating clinical reasoning skill acquisition by student physical therapists (Boucher, Robertson, Wainner, & Sanders, 2013; Huhn & Deutsch, 2011; Huhn et al., 2013; Rowe, 2012; Rowe, Bozalek, &

Frantz, 2013; Seif et al., 2013). For instance, Boucher et al. (2013) described a flipped classroom model which allowed for extra time during class sessions for discussions about clinical reasoning in musculoskeletal physical therapy. Other studies investigated the effects of social networks and computer programs on enhancing learning and communication between physical therapy educators and their students (Rowe, 2012; Rowe et al., 2013; Seif et al., 2013).

Clinical reasoning specific courses designed to facilitate student clinical reasoning skill development was the third theme identified (Caeiro, Cruz, & Pereira, 2014; Eduardo Brazete Cruz, Caeiro, & Pereira, 2014; Huhn, 2017; A. H. Miller, Tomlinson, Tomlinson, & Readinger, 2017). For example, the effects of a specific course developed to promote narrative reasoning skill in student physical therapists has been described (Caeiro et al., 2014; Eduardo Brazete Cruz et al., 2014).

The final theme was implementation of case-method teaching for facilitating clinical reasoning skill acquisition (Boucher et al., 2013; Darrah et al., 2006; Gillardon & Zipp, 2002; Huhn, 2017; Huhn & Deutsch, 2011; Huhn et al., 2013; Keiller & Hanekom, 2014; Ladyshewsky, 2002, 2004; A. H. Miller et al., 2017). For instance, Boucher et al. (2013) found their flipped classroom model allowed for inclusion of case-method teaching where students worked in clinician/client pairs to practice conducting a physical therapy examination and plan of care development in hypothetical musculoskeletal cases. Gillardon and Zipp (2002) implemented case-method teaching presented via written case studies to develop clinical reasoning skill in students. Of these ten studies, a total of four examined the effect of case-method teaching presented via simulated patient (Boucher et al., 2013; Ladyshewsky, 2002, 2004; A. H. Miller et al., 2017). Simulated patients are actors trained to portray a clinical case scenario accurately for promoting learning and skill development (Ladyshewsky et al., 2000).

Five studies examined case-method teaching presented via written case study (Darrah et al., 2006; Gillardon & Zipp, 2002; Huhn, 2017; Huhn & Deutsch, 2011; Huhn et al., 2013). Lastly, two studies investigated the effects of case-method teaching presented via virtual format (Huhn & Deutsch, 2011; Huhn et al., 2013).

Teaching clinical reasoning. A total of 19 studies investigated instructional strategies implemented to develop clinical reasoning skill acquisition. One instructional strategy implemented was use of frameworks such as the Systematic Clinical Reasoning in Physical Therapy Tool and Hypothesis-Oriented algorithm for Clinicians (Baker et al., 2017; Gillardon & Zipp, 2002). Clinical reasoning frameworks are tools practitioners may follow when engaged in the clinical reasoning process. Clinical frameworks have many advantages such as providing practitioners external cues to focus their cognition while engaged in clinical reasoning. Regarding professional education programs in the U.S., it was identified that the two most implemented clinical reasoning frameworks in the classroom were the APTA's Patient-Client Management Model and the WHO's International Classification of Functioning, Disability and Health Model (Christensen et al., 2017). Interestingly, other studies identified that students implemented a following protocol strategy when working through musculoskeletal clinical problems (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017). These studies found that following protocol as a clinical reasoning strategy was implemented mostly by students in the first 2 years of their professional education programs and that the frequency of this strategy decreased after completion of their first clinical education experiences. Lastly, two clinical reasoning frameworks (i.e., SCRIPT and PT-CRT) have been described and implemented in post-professional education programs but their utility in professional education remains unknown at this time.

Investigations into the incorporation of technology in the classroom for developing clinical reasoning skills in students have been met with mixed results. For example, Rowe (2012; 2013) reported that the inclusion of Google Drive and social networks in physical therapy curricula allowed for improved collaborative experiences between students and enhanced practice knowledge and critical self-reflection, all recognized as core dimensions of effective clinical reasoning in the health professions (Higgs & Jones, 2008). Additionally, Seif et al. (2013) identified significant increases on the Self-Assessment of Clinical Reflection and Reasoning instrument, a valid and reliable tool for measuring perceptions of clinical reasoning capability, in students following an online clinical reasoning lesson module developed in the Moodle Management System. Conversely, studies that have investigated the effects of virtual/web-based client simulations have been found to not significantly improve clinical reasoning skill acquisition in students when compared to in-classroom experiences (Huhn & Deutsch, 2011; Huhn et al., 2013).

The effects of specifically designed courses for clinical reasoning development have been investigated. The findings from these studies have been promising. For instance, it was found that a standalone narrative reasoning course assisted students develop a greater appreciation for those societal and psychological factors that contributed to the development of narrative reasoning skill and client-centered practices (Caeiro et al., 2014; Eduardo Brazete Cruz et al., 2014). Additionally, a “Critical Reasoning” course designed to promote clinical reasoning skill development in students was found to increase their willingness to engage in reflection, a metacognitive skill considered to be a core dimension of clinical reasoning capability (Christensen, Jones, Higgs, & Edwards, 2008; Huhn, 2017).

The most researched instructional strategy for developing clinical reasoning skill in students was case-method teaching. Case-method teaching is an instructional strategy whereby a clinical problem grounded in actual real-world experiences are created to assist students develop knowledge, problem solving strategies, and discipline specific skills (Jensen et al., 2013; McGinty, 2000). One advantage of case-method teaching are the multiple ways it can be presented to students. For example, cases can be presented via written case-study, audio/video recordings, computer simulations, or live simulated patients (McGinty, 2000). The two most described presentation methods in this review were written case study and simulated patient. Every study in this review that investigated case-method teaching presented via written case study all reported positive effects. However, Huhn et al. (2013) found that increases in scores seen on the Health Sciences Reasoning Test, a reliable instrument for measuring critical thinking in health science students, were not statistically significant in their written case study group. Interestingly, all studies investigating clinical reasoning hypotheses generated and strategies implemented by physical therapy students were under the condition of case-method teaching presented via simulated patient (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; Ladyshewsky, 2004). These studies found that students implemented a wide range of hypothesis categories and strategies when working through clinical problems presented via live simulated patients. However, no research was found that investigated physical therapy student reasoning hypotheses when cases were presented in other formats. Only one study investigated the effects of varied case presentation methods on physical therapy student clinical reasoning (Huhn et al., 2013). In that study, Huhn et al. (2013) compared written case study to web-based computer simulations and discovered no significant differences in total scores on the Health Science Reasoning Test between these groups. However, the Health Science Reasoning Test is designed to measure critical-thinking skill, only one dimensions of clinical reasoning capability (Christensen et al., 2008).

Physical therapy student perceptions of clinical reasoning. A total of 14 studies discussed physical therapy student's perceptions of clinical reasoning in professional education. From these studies three main themes were identified. The first theme detailed how physical therapy students perceived clinical reasoning in the physical therapy profession (Cruz et al., 2014; Cruz, Moore, & Cross, 2012; Furze et al., 2015; Hendrick et al., 2009). All four of these studies identified that students considered clinical reasoning as a therapist-centric process at some point in their professional education. Two of these studies presented longitudinal findings (Furze et al., 2015; Hendrick et al., 2009). First, Furze et al. (2015) described three tiers of clinical reasoning development students go through during their professional education. For example, students at the beginning of their professional education programs were more rigid and therapist-centric in their thought processes whereas students at entry-level were more client-centered and flexible in their reasoning. Similarly, Hendrick et al. (2009) identified five conceptualizations students have when they progress through their respective programs with beginning reasoning exemplified by therapist-centric thinking and transforming into a more client-centered process inclusive of reflective thinking.

The second theme was how physical therapy students perceived they best learned clinical reasoning during their professional education (Babyar et al., 2010; Babyar et al., 2003; Caeiro et al., 2014; Gillardon & Zipp, 2002; Loghmani, Bayliss, Strunk, & Altenburger, 2011; Maas et al., 2014; A. H. Miller et al., 2017; Roche & Coote, 2008; Snodgrass, 2011). For instance, Maas et al. (2014) 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, it was found that physical therapy students preferred case-method instruction for their clinical reasoning development more than group projects or algorithms/flowsheets in their musculoskeletal courses (Babyar et al., 2010). Two studies investigated enhanced use of technology in the classroom for promoting student learning of clinical reasoning (Rowe et al., 2013; Snodgrass, 2011). For instance, Rowe et al. (2013) found that integrating Google Drive in the classroom assisted in changing physical therapy students' perceptions of learning from being a teacher driven process to a self-driven one. However, Snodgrass (2011) discovered that students perceived technology-based instruction as less valuable than in-class sessions for their learning. Lastly, two studies described student perceptions of educational experiences designed to develop specific clinical reasoning skills such as narrative reasoning and reflection (Caeiro et al., 2014; Roche & Coote, 2008). Both these studies found that students believed these educational experiences positively contributed to their learning of clinical reasoning. The final theme were perceptions of instructional method contribution to student professional development and self-identity (Cruz et al., 2014; Rowe et al., 2013). For instance, students believed the addition of Google Drive to an "Applied Physiotherapy" module assisted in transforming their perceptions of learning from being remote memorization to the recognition of the importance of acquiring those traits and skills necessary to become a life-long learner (Rowe et al., 2013).

Perceptions of clinical reasoning. This systematic review identified a total of 14 studies that described physical therapy student perceptions of their learning of clinical reasoning. From these studies three main themes were identified. First, was the effect of instructional methods for their learning of clinical reasoning. For example, students perceived a 2-week patient examination module administered immediately prior to their first clinical education experience assisted in their preparation to perform clinical examinations on clients. Interestingly, student perceptions of case-method instruction were the most reported in this literature review (Babyar et al., 2003; Gillardon & Zipp, 2002; Loghmani et al., 2011; Maas et al., 2014; A. H. Miller et al., 2017). These studies indicated that students generally regard case-method teaching as beneficial to their learning because these experiences more closely mirrored real world clinical experiences they could expect to encounter during their clinical education experiences. 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 does (Maas et al., 2014). This is interesting and suggests students perceived their reflection-in-action and reflection-on-action as better contributors to their learning than feedback from more experienced educators did. This highlights the importance of developing sound metacognition skills, such as reflection, in physical therapy students when preparing them for their clinical education experiences.

The second theme identified was student perceptions of clinical reasoning for the physical therapy profession. These studies reported that students perceived clinical reasoning as a therapist-centric process at some point in their professional education. However, longitudinal studies found that student perceptions of clinical reasoning changed from therapist-centric to client-centered during their professional education (Furze et al., 2015; Hendrick et al., 2009).

Lastly, two studies outlined how instructional strategies impacted student professional development. 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 (Cruz et al., 2014).

Leading Change in Educational Settings

One purpose for conducting this research is to identify and implement instructional strategies that best facilitate the acquisition of clinical reasoning skills in physical therapy students. The findings from this systematic review and my future research will be influential on the instructional strategies I choose to implement in the classroom environment. Additionally, as an educational leader I aspire to guide other physical therapy educators. Doing so may require change initiatives that affect educational policy and practices at large. For instance, curricular changes that include more experiential learning may be warranted. These initiatives are more likely to succeed if guided by strategies found to produce positive outcomes. As such a brief review of the change leadership literature was warranted.

A significant amount of literature exists regarding change leadership and management. These studies are largely based on observations or interviews from leaders within organizations that have undergone change initiatives (Kotter, 2007; Rowland & Higgs, 2008). However, these studies have largely focused on traditional hierarchical organizations. For instance, Kotter (2007) explained why change efforts fail from observing organizations such as the Ford Motor Company, General Motors, and Bristol-Myers Squibb whereas, Covey (1989) leaned on experiences with International Business Machines Corporation when he described 7 habits that successful individuals possess. However, institutions of higher education typically embrace a more distributed organizational culture (Buller, 2015). Distributed leadership has been defined as leadership that shares influence (Northouse, 2016). According to Buller (2015), establishing the need for change in higher education should be inclusive of models that allow for individuals involved in the change process to see multiple perspectives of the need for and potential outcomes of the change initiative. Specifically, Buller identified Bolman and Deal’s four-frame model and de Bono's six thinking hats model as one's inclusive of providing multiple perspectives. However, Buller also believed that the four-frame model wasn't inclusive of enough perspectives and that de Bono's six hat model doesn't translate well for contemporary multi-cultural audiences. Therefore, he proposed a ten analytical lenses model designed specifically for institutions of higher education. Each lens assists in framing change initiatives from different perspectives such as seeing what's to come, seeing where you have been, seeing what could go right, and seeing what could go wrong. Additionally, it has been suggested that leaders need to do more than understand theoretical concepts of change, they need to practice the change they wish to make (Fullan, 2011; Rowland & Higgs, 2008). For instance, Fullan (2011) believed that practice allows leaders to see past the shortcomings many theoretical models of change possess and create change initiatives that are individually tailored for the team members and organization impacted by the change. This occurs because according to Fullan, change leadership happens in the natural habitat. Change leaders must learn what it is that their team members do on a day-to-day basis in the actual environment they work in.

Several change theory models have been described in the literature. Change leaders should be knowledgeable of best practice theory so that their change efforts are grounded in empirical best practices. However, caution should be taken when implementing change models to ensure that all team members are "on-board" with ongoing change initiatives. Additionally, special considerations must be made for change efforts within distributed organizations such as institutes of higher education. When attempting to make changes to policies and procedures that other team members assisted to create, the change leader should frame the need for change using models that allow for multiple perspectives and implement change models that allow for flexibility within the process.

Conceptual Framework

The purpose of this research was to ascertain the effects of case-method presentation on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students working through a musculoskeletal clinical problem. The focus was to develop a better understanding for how different environmental factors (simulated patient vs. written case study) impacted the cognitive processing of students. Several conceptual frameworks contributed to informing the study's findings.

Levels of processing and goal focusing. First, Marton and Säljö (1976) described two levels of processing students exhibit when reading texts for learning. Their work intended to change the focus of student learning when reading texts from how much they learned to what they learned. To do so, they used a qualitative approach to derive the depth of comprehension students had from text readings. Their work found students exhibited either *surface-level* or *deep-level* processing for the learning tasks. They stated that students exhibiting surface-level processing focused on memorizing as much of the reading topic as possible whereas deep-level processors focused on understanding the authors intention for writing the reading texts. For example, surface-level processors used verbalizations such as, "I just concentrated on trying to remember as much as possible," (p.9). In contrast deep-level processors used verbalizations such as, "I tried to think what it was all about," (p.9). It's important to note, the students in Marton and Säljö's work were subjected to similar environmental factors. That is, they all read the same text passages with the same instructions for understanding the reading material. However, despite these similarities, students exhibited different levels of processing for the task. One possible explanation for this is students developed their own standards for self-determining reaching an acceptable level of understanding for the reading materials. For instance, some students felt they could meet the instructors expectations by simply memorize the passage without the need for developing an understanding of the author's message (i.e., superficial-level processing). On the other hand deep-level processes may have developed self-determined goals that required further understanding of the author's intent for writing the passage. Inferences from Marton and Säljö's work are applicable to better understanding the results this study. For instance, clinical reasoning in physical therapy has been characterized as being situated in a biopsychosocial model of health (Jones et al., 2008). A biopsychosocial model of health requires clinicians to attend to environmental and psychosocial factors in addition to biological ones contributing to a client's current level of health and functioning. According to Jones, Edwards, and Jensen (2018), physical therapists are good at focusing on biological factors but advocate the need for physical therapy clinicians to continue to incorporate environmental and psychosocial factors in their reasoning. Therefore, we may be able to differentiate different levels of reasoning participants exhibit based on their application of a biopsychosocial approach for their hypothetical patient. For instance, participants who focus their clinical reasoning primarily on biological factors with minimal or no consideration for their client's environmental and/or psychosocial factors could be said to be exhibiting surface-level reasoning.

In the previous section I discussed differences in levels of processing learners exhibit when reading texts and how levels of reasoning processing may be differentiated in physical therapy. Moving on I now turn my attention to factors that may influence the reasoning processes students choose to implement when involved in learning experiences and by extension how these factors are attributable to physical therapy clinical reasoning. In 2010, McCrudden, Magliano, and Schraw developed a goal-focusing model for conceptualizing how self-driven goals (*personal intentions*) and environmental factors (*given intentions*) affect student *goals*, *processing*, and *learning* from reading texts (Figure 2.2).

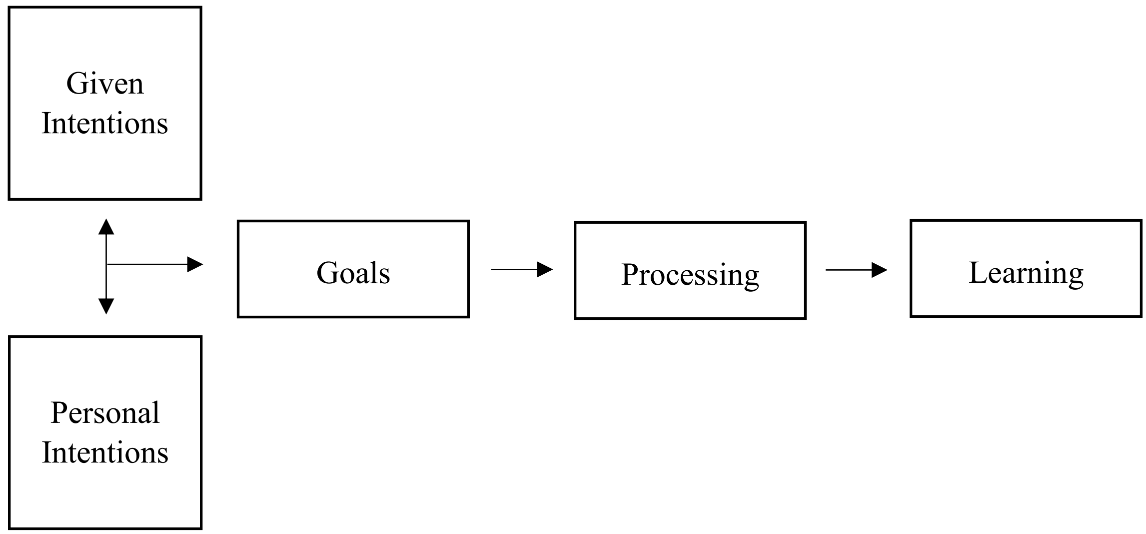

Figure 2.2. Goal-focusing model. Adapted from "Exploring how relevance instructions affect personal reading intentions, reading goals and text processing: A mixed methods study," by M. T. McCrudden, J. P. Magliano, and G. Schraw, 2010, *Contemporary Educational Psychology, 35,* p. 230.

They defined personal intentions as self-determined criteria students have for understanding reading texts. Additionally, given intentions were defined as those environmental factors that focuses student attention to the text readings (e.g., teacher instructions). McCrudden et al. (2010) suggested that an interplay takes place among personal and given intentions that prompt students to generate personal goals for the reading task. With a goal in mind students develop and implement reading processes facilitating their learning. The goal-focusing model of McCrudden et al. (2010) provides a framework for understanding the effect of case-presentation on the clinical reasoning hypotheses generated and strategies implemented by physical therapy students in this study. That is, student participants were provided with two primary *given intentions* in this study, instructions to arrive at a diagnostic conclusion from the case findings and the independent variable for this research (i.e., case presentation method). These environmental factors (i.e., *personal intentions* and *given intentions*) influence the *goals* student participants make for the problem-solving session. They then executed cognitive processes (i.e., reasoning hypotheses and strategies) for understanding relevant clinical data to meet their pre-determined goals and promote *learning* that may be called upon in future clinical situations with similar features.

The work of Marton and Säljö (1976) and McCrudden et al. (2010) provide frameworks for understanding the cognitive processes learners exhibit influenced by environmental factors such as student aims for the learning experience, teacher instructions, and the inherent nature of the learning task itself. Each of these factors impacts student's cognition by imposing load on their memory system. The next section will discuss how these factors can influence the cognitive processes students exhibit during learning tasks and how learning can take place when these taxes on memory processing is imposed.

Cognitive load. Cognitive Load Theory is focused on how instructional design impacts student learning and behaviors. This theory centers on human memory architecture and how instructional strategies can be manipulated to ensure learning objectives remain within a subject's memory capability (Sweller, Ayres, & Kalyuga, 2011). Assumptions of Cognitive Load Theory include a limited working memory capacity for novel learning whereas its capacity for schemas retrieved from long-term memory are unlimited (G. A. Miller, 1994; van Merriënboer & Sweller, 2010). Three main types of cognitive load are identified in this theory–intrinsic, extraneous, and germane (van Merriënboer & Sweller, 2010). Intrinsic cognitive load pertains to those learning tasks that are inherent in the skill(s) being taught. According to Sweller, van Merriënboer, and Paas (1998) intrinsic load cannot be altered because it is dictated by variables inherent to the learning task and the personal attributes of the learner. Extraneous load refers to how learning tasks are presented (Sweller et al., 2011). Extraneous load can be altered by teacher instructions or how material is conveyed to learners. Lastly, germane load is the remaining cognitive resources in working memory after accounting for extrinsic and intrinsic load (van Merriënboer & Sweller, 2010). It is within this remaining load that learning takes place. That is, when the additive effects of intrinsic and extraneous cognitive load supersede the learners total working memory capacity it is said that learning becomes challenged and impedes their learning. On the other hand, if intrinsic load and extraneous load are minimal, the learner will have larger remaining working memory capacity to handle the amount of germane load needed to synthesize new knowledge into their long-term memory. When measuring intrinsic load, *elemental interactivity* has been described as the number of tasks that the learner must engage simultaneously (Kalyuga & Singh, 2016). In this study, participants assigned to the simulated patient group are expected to be exposed to more elemental interactivity than the written case study group. This is because during the simulated patient experience participants will need to conduct their own subjective interviews and perform relevant objective tests and measures for obtaining relevant clinical data from the case. They will also need to strategize how to remember these clinical findings (e.g., memorization or written notes). In contrast participants in the written case study group will have no need to conduct client interviews or perform selected tests and measures. Instead all relevant examination findings will be presented in type print which should be easy to read reducing the need for memorization or writing out the examination findings.

Cognitive Load Theory assists in identifying how the structure and presentation of learning tasks affects a student's ability to learn desired instructional objectives. The main questions of this research are the effect of case method presentation (i.e., extraneous and intrinsic load) on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when working through a musculoskeletal clinical problem. I hypothesized that subjects assigned to the simulated patient encounter will be exposed to higher levels of elemental interactivity and therefore have increased intrinsic and extraneous loads compared to those assigned to the written case study group. Differences in the number and types of clinical reasoning hypotheses generated, strategies implemented, or errors made between these groups may be partially explained by Cognitive Load Theory.

Domain learning. Lastly, the Model of Domain Learning was adopted as a conceptual framework for this study. This model assists in describing differences between novel learners and experts in academic domains (Alexander, 2004). The Model of Domain Learning divides expertise into three levels, low (*acclimation*), middle (*competence*), and high (*proficiency*). Each level of expertise is described by the inter-play of three separate dimensions–knowledge, strategy, and interest–and each dimension with multiple strata. For example, individuals categorized in the *acclimation* level of expertise generally exhibit lower levels of domain and topic knowledge and implement more surface level strategies in their learning than compared to *proficient* individuals who possess significantly high levels of domain and topic knowledge, consistently demonstrate deep level processing strategies, and devote a significant level of personal investment into their continued learning. The Model of Domain Learning posits that any individual can become *competent* in an academic domain if they acquire an adequate level of new knowledge in the subject matter, a variety of strategy processes, or an increasing personal interest in the subject matter. In contrast individuals will need to acquire higher levels of all three dimensions of expertise to be recognized as *proficient* within that academic domain.

The Model of Domain Learning will assist in informing some of the discussion points in this study. For instance, the subject pool for recruiting my participants will be from student physical therapists who have fully acclimated to the domain of physical therapy and should be working at a competent level of expertise. Alexander (2004) has stated that at the *competence* level of expertise individuals may exhibit an early, middle, or late level of development. She described individuals exhibiting early competence score higher levels of subject knowledge and personal interest for the academic domain than individuals at the acclimation level. In contrast individuals at the mid competence level implement more deep level processing strategies and display even higher levels of personal interest in the subject matter domain than individuals functioning at the acclimation and early competence levels of expertise. This is interesting because I can assume the participants of this study may be functioning at different levels of *competence*. This may inform why certain participants generated the clinical reasoning hypotheses and implemented the clinical reasoning strategies they did when solving the musculoskeletal clinical problem. Additionally, it may inform why study participants interacted with each other the way they did. For instance, if one participant of the dyad is functioning at a higher level of *competence* than their partner it may be discovered that they implement higher level clinical reasoning strategies such as hypothetico-deductive reasoning or forward reasoning (e.g., pattern recognition).

Chapter 3: Methodology

Overview of Methods

This study sought to determine the effects of case-method teaching problem presentation on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students while working through a musculoskeletal clinical problem. First, participants were randomly placed into dyads. These dyads were then randomly assigned to the simulated patient or written case study group. Each problem-solving session began with dyads first receiving background information regarding the clinical case. After a round of thinking about the initial background information provided, each dyad worked through the clinical problem in the format they were assigned. For instance, participants in the written case study group received further subjective and objective data about the clinical case at predetermined stages in a manner that has been described previously (Rivett & Jones, 2008). Conversely, participants assigned to the simulated patient group performed a subjective history and physical examination of the "actor" to retrieve relevant clinical findings. This process was audio-video recorded for creating verbatim transcriptions of the problem-solving sessions. In addition to verbatim transcripts, student participants could make hand written notes to assist their thinking throughout the problem-solving session. Similarly, the primary investigator made analytic memos of observations as dyads worked through the clinical problem. These written notes supplemented the verbatim transcriptions, thus enriching the data set and substantiating the reliability of the quantitative and qualitative findings of this study.

Think-aloud methodology was implemented to capture the clinical reasoning hypotheses generated, strategies implemented, and errors made by participants during each problem-solving session. Immediately before each problem-solving session, dyads were educated on think-aloud verbalizations and performed a problem-solving task to determine their understanding of think-aloud methods. This warm up task was meant to provide adequate warm up for the participants to verbalize their internalized thoughts, a skill that can be difficult for some to perform (van Someren, Barnard, & Sandberg, 1994).

Participants

Participants for this research project were physical therapy students enrolled in an accredited Doctor of Physical Therapy Program located in northeast Florida. This population was chosen due to subject availability and the data collection methods implemented. Participants were recruited after completing the second year of their curriculum where all required course work in musculoskeletal physical therapy was completed. It is from this content the clinical problem was developed. Therefore, these participants should have offered a more thorough account of the clinical reasoning hypotheses and strategies physical therapy students produce when working through musculoskeletal clinical problems, as this material was recently taught to them.

Sample Size

Determining sample size in qualitative research may be dependent on many factors including site of the study, phenomenon under investigation, and the research questions (Marshall & Rossman, 2016). Furthermore, it has been suggested that most qualitative and mixed-methods health research studies average about four participants (Marshall & Rossman, 2016). Fonteyn, Kuipers, and Grobe (1993) have also supported using small sample sizes when pursuing detailed and exhaustive data, as increasing sample size could make the researcher's ability to draw meaningful conclusions about human knowledge more challenging. Additionally, Vogt (2007) has stated that even the smallest samples can provide accurate descriptions of phenomena provided the sample is representative of the population under investigation. For these reasons, a total of three dyad groups for the simulated patient group and four dyads for the written case study group was recruited for the study (*n* = 14). This sample size was selected to provide meaningful data while not overwhelming the investigator through the data collection and analysis processes.

Creating the Clinical Case

An important consideration for this research is the construction of the musculoskeletal clinical problem the student participants will clinically reason through. A single musculoskeletal case scenario was created for each dyad to work through. To ensure the case scenario exemplified a "typical" case presentation, three experts in the field of orthopaedic physical therapy assisted creating the musculoskeletal clinical problem. This process was also guided by available literature of expert consensus on key clinical features in diagnosing and treating the chosen musculoskeletal condition (Logerstedt et al., 2018). This procedure for creating the musculoskeletal clinical problem followed similar formats described in the physical therapy literature (Gilliland, 2017; Gilliland & Wainwright, 2017; McGinty, 2000).

Data Collection

Regarding verbal reports, concurrent and retrospective reports have been identified as most closely replicating the cognitive process (Ericsson & Simon, 1992). In retrospective analysis, participants perform the problem-solving task first, followed by reflection upon that process later. However, it has been suggested that obtaining accurate data via retrospection can be challenging due to the need for the participant to remember what they were thinking at the time of the problem-solving task, and that these participants can sometimes make their thoughts appear to be clearer and more coherent in retrospection than they were originally (van Someren et al., 1994). Conversely, concurrent reports require a person to talk while they think. This usually requires practice performing, as most people tend to internalize their thought processes when working through problems (Ericsson & Simon, 1992). Ericsson and Simon (1992) have advocated for the use of concurrent verbal reports when investigating the internalized thoughts of participants while they work through problems. According to their theoretical framework verbal reporting begins by bringing information to the attention of the person talking which is then processed into verbal codes in their working memory before words are vocalized. They believed concurrent verbal reports does not alter the cognitive processing of individuals in any way.

A similar framework for think aloud method has also been proposed (van Someren et al., 1994). In this model, sensory information is combined with information from long-term memory into working memory, the area where active information is kept. Within working memory new information is constructed and can be verbalized as protocols. In addition to producing verbal protocols from working memory, this new information can be stored in long term memory to be used again in the future. For these reasons' concurrent verbal reports via talk-aloud protocol was the primary data collection method implemented in this study.

Marshall and Rossman (2016) have described interaction analysis as a qualitative approach that focuses on exchanges between people in naturalistic environments. Interaction analysis using dyads allows for a natural dialogue to take place. Some advantages of dialogues are that they can be observed under natural circumstances, they should not disturb the memory processes of participants, and leave no chance for the participant to misinterpret their own cognitive processes (van Someren et al., 1994). Research has also supported that physical therapy students score significantly higher in their performance of history taking and physical examination findings and generate more ideas when paired as dyads when participating in simulated patient encounters (Ladyshewsky, 2002, 2004). Additionally, it has been suggested that audio and video recordings be used for data collection when implementing interaction analysis (Marshall & Rossman, 2016). Therefore, each problem-solving session was audio-video recorded. Verbatim transcriptions were created from these files and verified for accuracy.

Data Analysis

An iterative process using thematic analysis was implemented for coding the data. This process required repeated analysis of verbatim transcriptions to refine, eliminate, and add codes that best fit the collected data. This process began with identifying previous research on clinical reasoning by physical therapists from which to build upon for a better understanding of the clinical reasoning processes physical therapy students implemented when working through the musculoskeletal clinical problem. For instance, the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students while working through a clinical problem has been established (Gilliland, 2017) and was considered when building the finalized coding scheme in this study (Tables 3.1–3.3).

Table 3.1

Clinical Reasoning Hypotheses for Patient Evaluation

Code	Definition
Health condition	Includes diseases, disorders, and injuries
Anatomical structure	Parts of the body such as bones, joints, muscles, and their components
Body function/Impairment	Are physiological or biomechanical functions of body systems
Activity	Execution of a task by an individual
Participation	Involvement of a life situation
Phase	Stage of healing including inflammatory, fibroblastic, and remodeling
Mechanism of Injury	Includes overuse, acute, and systemic
Causal/Contributing	The named hypothesis explains the underlying cause of the injury
Causal function	Body function is identified not as the primary injury but explains its underlying cause
Patient impact	Identifies how the condition is affecting the patient's life experience
Rule out	The named hypothesis is no longer being considered
Structure rule out	The named body structure is no longer being considered

Note. Adapted from "Physical therapist students' development of diagnostic reasoning: A longitudinal study," by S. Gilliland, 2017, *Journal of Physical Therapy Education, 31,* p. 34.

Table 3.2

Clinical Reasoning Patterns for Patient Evaluation

Code	Definition
Trial and error	No hypothesis or plan; moving from one structure to another with no clear line of reasoning
Following protocol	Remembering exam forms from clinic or class
Rule-in/Rule-out	Beginning with one or more hypotheses; testing to include or exclude, then moving on to another hypothesis
Activity	Generating hypotheses and using organized plan of testing to rule out or rule in
Hypothetico deductive	Involvement of a life situation
Reasoning about pain	Using descriptors of pain to rule in or rule out

Note. Adapted from "Physical therapist students' development of diagnostic reasoning: A longitudinal study," by S. Gilliland, 2017, *Journal of Physical Therapy Education, 31,* p. 34.

Table 3.3

Reasoning Errors

Code	Definition
Jumping to conclusions	Taking one piece of information that was necessary but not sufficient to draw a certain conclusion, and jumping to that evaluation without considering other findings necessary for drawing that conclusion
Perseveration	Taking necessary but not sufficient piece of diagnostic information to rule in a particular hypothesis, and then continuing to rationalize that hypothesis as other information was collected, even when it ran counter to the participant's conclusion
Disregard	Ignoring unfamiliar information and moving on because of uncertainty concerning how to assess the unfamiliar information

Note. Adapted from "Physical therapist students' development of diagnostic reasoning: A longitudinal study," by S. Gilliland, 2017, *Journal of Physical Therapy Education, 31,* p. 35.

A fully crossed design to the data analysis was implemented to address the reliability of the finalized coding schemes. The initial coding was done by the primary investigator. After carefully considering code application throughout all transcripts, a second physical therapy educator then coded random sections of the verbatim transcriptions. From there inter-rater reliability was calculated using Cohen's kappa which has been described as the ideal statistic to use for fully crossed designs with only two coders (Hallgren, 2012). Kappa statistics range from -1 (perfect disagreement) to 1 (perfect agreement) with a value of zero indicating complete random agreement. It has been suggested that kappa values between 0.61–0.80 indicate a substantial level of agreement between coders. Therefore, a kappa value of ≥ .61was required for accepting the finalized coding schemes. This method for calculating inter-rater reliability has been implemented previously in the physical therapy literature (Gilliland, 2017; Gilliland & Wainwright, 2017).

Quantitative Analysis

First, the mean distribution scores with standard deviations will be calculated for clinical reasoning hypotheses, strategies, and errors by each group. These data may offer insight for those factors that weighed most or least for students when working through a musculoskeletal clinical problem. For instance, we may see the written case study group demonstrate more episodes of trial and error reasoning strategy than the simulated patient group. This method of data analysis has been used previously in similar studies investigating clinical reasoning by physical therapy students (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017).

Second, statistical analysis investigating for significant differences between groups will be made. Independent samples T-tests are special cases of one-way ANOVA utilized when researchers want to compare two groups for statistically significant differences between them (Portney &

Watkins, 2000). One purpose of this study was to identify differences between the types, and frequency of clinical reasoning hypotheses, strategies, and errors generated by students dependent upon problem presentation type (simulated patient or written case study – independent variables). In order to justify the use of the independent samples T-test the assumptions of independence of observations, homogeneity of variance, and normality of the dependent variable across groups must be met (Lomax & Hahs-Vaughn, 2012). However, the dependent variables of this investigation (clinical reasoning hypotheses, strategies, and errors) are categorical (codes) and therefore, cannot be assumed to be distributed normally across the population, violating the assumption of normality. Portney and Watkins (2000) have described the Mann-Whitney *U*-Test as a powerful non-parametric alternative to independent samples T-tests and therefore used for determining quantitative differences between the groups. Lastly, effect sizes will be calculated for all dependent variables. Effect sizes are statistical measures of how strongly the independent variable affects the dependent variable. Tomczak and Tomczak (2014) stated that effect sizes for the Mann Whitney *U*- test can be easily calculated manually and proposed the following equation:

$$r^2 = \eta^2 = Z^2/n$$

Therefore, this equation was used for calculating effect sizes for each dependent variable.

Qualitative Profile

Marshall and Rossman (2016) have supported the use of small sample sizes when collecting qualitative data. However, when performing quantitative analysis from small samples it has been suggested that the risk for making type II errors increases (Vogt, 2007). Therefore, a qualitative profile was created to discuss general themes discovered from the verbal data collected. This qualitative profile was created over two stages. First, verbatim transcripts of the problem-solving sessions were grouped according to their similarities and differences of early-identified broad themes. For example, those verbatim transcripts in which the dyad reached a correct diagnostic conclusion would be grouped together, and those transcriptions that dyad groups made similar clinical reasoning errors will be placed in a separate grouping. Second, each broad theme identified in step one will undergo a more detailed analysis. For instance, verbatim transcripts that were combined for reaching a correct diagnostic conclusion will be scrutinized for those clinical reasoning hypotheses and strategies that best assisted in drawing a correct diagnostic conclusion. Each stage of the qualitative profile was completed with consideration for the literature consumed that informed this study. To ensure credibility of the qualitative profile the themes were subjected to peer review from physical therapy educators as well as physical therapy expert clinicians in orthopaedic physical therapy. The qualitative profile was refined until a consensus that the identified themes were applied appropriately and accurately was reached. This process for developing a qualitative profile has been implemented previously in the physical therapy literature (Hendrick et al., 2009).

Reliability and Validity

Several procedures to strengthen the reliability and validity of this study were implemented to ensure the conclusions drawn were as trustworthy as possible. As previously described, the musculoskeletal clinical problem was created in collaboration with other formally recognized content experts, guided by literature informing key clinical features of the selected condition in orthopaedic physical therapy. This methodology for creating the clinical case has been previously utilized in the literature (Gilliland, 2017; Gilliland & Wainwright, 2017) and ensured the musculoskeletal problem created exemplified a “typical” clinical presentation. The written case study was created by the primary investigator and verified for accuracy and content by those clinicians who assisted in creating the clinical case.

Another consideration is the accuracy in which the actor portrays the musculoskeletal clinical problem to each dyad in the simulated patient group. For instance, significant inaccuracies by simulated patients have been identified in depicting socio-emotional dimensions of clinical cases in the literature (Erby, Roter, & Biesecker, 2011). Tamblyn, Klass, Schnabl, and Kopelow (1991) identified four assumptions that are made when implementing simulated patient procedures. Two of these assumptions apply only when multiple simulated patients are utilized to present a single clinical problem simultaneously (replicability), or at multiple sites (portability) and do not apply to this research. However, this research does assume that the actor will accurately portray the musculoskeletal clinical problem the same with each dyad. According to Tamblyn et al. (1991), to ensure accuracy of clinical problems by simulated patients, the actor must present the clinical problem the same from one participant to the next (reproducibility) and be absent of bias, which they defined as the failure of an actor to present essential clinical features when probed by student participants. Any inaccuracies in the portrayal of the musculoskeletal clinical problem on the actor's part could jeopardize the data collected and any conclusions that could be drawn from this study. It has been suggested that reasons for actor inaccuracies include factors specific to the actor selected, conditions associated with simulated patient training, and factors related to length of time per session or the number of sessions an actor is asked to perform (Tamblyn, Klass, Schanbl, & Kopelow, 1990). Of these factors, the greatest amount of variance was seen in factors that were attributed to the person selected to be the simulated patient. Most interestingly was that the greatest amount of variance from that factor was found when the actor did not have a good understanding of the clinical problem they were presenting to students. For this reason, the actor selected for the simulated patient encounters was one of the content experts who assisted in creating the musculoskeletal clinical problem. Additionally, to ensure that an acceptable level of simulated patient reproducibility between each dyad was reached, the primary investigator was present during each simulated patient encounter and corrected any essential clinical features of the case that were not portrayed accurately by the actor. This procedure has been implemented in similar studies previously to enhance trustworthiness (Gilliland, 2017; Gilliland & Wainwright, 2017).

Peer debriefing has been defined as the use of experts to discuss and clarify key concepts regarding coding schemes and to ensure that the investigation is methodologically sound (Marshall & Rossman, 2016). Several instances of peer debriefing were utilized in the data analysis. For instance, the use of expert physical therapists in the field of orthopaedic physical therapy to develop the case problem added a layer of trustworthiness that the problem portrayed a “typical” case presentation. Peer debriefing also took place throughout the iterative process of finalizing the coding schemes of clinical reasoning hypotheses generated, strategies implemented, and errors made by student physical therapists during the problem-solving sessions. Lastly, peer debriefing took place while developing the qualitative profile. The inclusion of inter-coder reliability statistics ensured the finalized coding schemes are defined and applied appropriately.

Chapter 4: Analysis and Results

This chapter highlights relevant findings that assisted in answering the study's main research questions– *What effect does case-presentation have on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students working through a musculoskeletal clinical problem?* Participants were randomly placed into dyads and then randomly assigned to either the simulated patient or written case study group. After data collection, verbatim transcriptions were created and verified for accuracy. Initial codes were created and refined until an acceptable level of inter-rater reliability was met (κ = .75). All transcriptions were then recoded to ensure the finalized codes were applied accurately across all verbatim transcriptions. The following sections will present the findings regarding demographics of the study participants, quantitative findings for clinical reasoning hypotheses categories, strategies, and errors, and conclude with themes identified through qualitative analysis.

Examination of Condition Differences

Demographic data for participants were collected and compared for ascertaining any potential differences between groups (Table 4.1). Means and standard deviations were calculated for participant age in years (written case study: M = 26.13, SD = 2.64; simulated patient: M = 25.5, SD = 1.38) and grade point average (written case study: M = 3.64, SD = .25; simulated patient: M = 3.72, SD = .11). These data did not appear to reveal any significant differences between groups. Additionally, percentage calculations were made to inform group demographics regarding gender, race, ethnicity, and interest area of physical therapy practice. It was detected that the simulated patient group had a higher percentage of women whereas the written case study group had a larger percentage of participants who self-identified orthopaedics as a specialty area of interest. Regarding race and ethnicity, the population was homogenous for self-identifying as White, non-Hispanic or Latino individuals.

Table 4.1

Population Description

	Simulated Patient	Written Case Study
	M (SD)	*M (SD)*
Age (years)	25.50 (1.38)	26.13 (2.64)
GPA	3.73 (.11)[a]	3.64 (.25)
Woman Gender	66.66%	25.00%
Race (White)	100.00%	100.00%[b]
Ethnicity (Not Hispanic or Latino)	100.00%	100.00%[b]
Interest (orthopaedics)	50.00%	87.50%

[a]Information not provided by one participant

[b]Information not provided by one participant

Quantitative Analysis

A quantitative analysis was performed for each research question of the study. This analysis was performed after the finalized coding schemes were applied to the verbatim transcriptions. The finalized coding schemes were developed following procedures outlined in the methodology. First, initial codes were assigned to verbalizations from the transcriptions in consideration of the literature review for this study and other readings (Doody & McAteer, 2002; Gilliland, 2014, 2017; Jones et al., 2018; Jones et al., 2008; Ladyshewsky, 2004). To enhance the credibility and trustworthiness of the finalized coding schemes a fully crossed design using two coders was conducted for determining inter-rater reliability. Initial kappa values ranged from κ =

.49–.54 prompting the need for peer debriefing sessions for clarifying code definitions, and their application to the verbatim transcriptions until an acceptable level of inter-rater reliability of κ = .75 was achieved indicating substantial agreement for the finalized codes (Hallgren, 2012). After achieving an acceptable level of inter-rater reliability, verification that the finalized coding schemes were applied accurately to all the verbatim transcriptions was made. A quantitative analysis of the verbatim transcriptions using the finalized coding schemes per the methodology was conducted (Tables 4.2, 4.4, and 4.6).

A total of 1,420 verbalizations were tabulated from the verbatim transcriptions. Regarding hypothesis categories, a total of 529 verbalizations were tabulated for the simulated patient group compared to 583 for written case study. Similarly, the simulated patient group had more reasoning strategy verbalizations with a total of 151 compared to 112 for the written case study group. Lastly, more reasoning errors were identified in the written case study group with 26 errors compared to 19 among the simulated patient group. However, these frequencies are likely skewed because there were four dyads assigned to the written case study condition and only three to the simulated patient condition. Therefore, mean averages with standard deviations were used for comparing groups instead of raw frequencies. The following sections highlight the results of the quantitative analysis for each research question in this study.

Effect of case presentation on reasoning hypotheses. Reasoning hypotheses are the internalized thoughts and judgements clinicians have regarding their client's current level of function for participating in meaningful life experiences (Gilliland, 2017; Jones et al., 2018; Jones et al., 2008). Hypothesis categories are clinical judgements that guide physical therapy clinicians determine the procedural flow of client interactions from examination to outcomes as outlined in the *Guide to Physical Therapist Practice* (American Physical Therapy Association, 2014b; Jones et al., 2018). After analyzing the results, it was found that study participants generated a total of 14 different reasoning hypotheses when working through the musculoskeletal clinical problem (Table 4.2). The finalized reasoning hypothesis categories were generated in consideration of the literature review and other sources that have investigated and described the clinical reasoning hypotheses physical therapy experts and students generate during the clinical reasoning process and represent the entire range of clinical judgements the study participants had during the problem solving sessions (Gilliland, 2014, 2017; Gilliland & Wainwright, 2017; Jones et al., 2018; Jones et al., 2008; Ladyshewsky, 2004). The table provides the names of the finalized hypothesis categories and their definitions. The right most column of the table provides an example from the verbatim transcriptions that represented each hypothesis category.

Table 4.2

Hypothesis Categories

Code	Definition	Example
Health condition	Named pathology that is thought to be contributing toward the client's overall presentation	*He could have arthritis too*
Anatomical structure	Tissues, organs, joints, muscles, and any other part of the body without mention of a specific health condition	*That's meniscus*
Body functioning/impairment	Consideration of psychological, physiological, or anatomical structure and functioning	*He's got flat feet*
Activity/Participation	Performance of functional movements (e.g., walk, sit) or involvement in life situations (e.g., work, or sports teams)	*Weekly golf outings*

Table 4.2 (continued)

Code	Definition	Example
Contributing factors	Factors that develops, maintains, and/or progresses a client's problem	*Because they're heavy and that's weight on joints*
Client perspectives	Consideration of the client's beliefs regarding their current health condition and/or those factors that may be contributary	*You were brought to us because of pain in your left knee. Is that correct?*
Symptom characteristics	Consideration of the quantity and/or quality of symptoms arising from body tissues/structures (e.g., pain, or paresthesia)	*Let me know if this makes your symptoms feel worse*
Mechanism of Injury	Consideration of intrinsic/extrinsic factors that caused the underlying condition	*Did anything happen? Did you fall? Get hit?*
Personal factors	Attributes unique to the client	*Lives in single-story home*
Minimizing Reasoning Errors	Recognition of the need for further inquiry and/or testing to minimize potential reasoning errors	*I keep thinking we should do Thessaly's later*
Phase	Consideration of the client's stage of healing (e.g., acute, subacute, or chronic)	*3 months, progressive, so getting worse*
Precautions/Contraindications	Assessment of red/yellow flag items; Consideration for need of safety tests (e.g., Vertebral artery test, or Babinski reflex sign)	*Looking at cardiac risk factors…*
Management/Treatment considerations	Health management considerations including need for referral to another practitioner, client advocacy, and/or prescribing procedural interventions	*Maybe we should refer to the primary care physician*
Follow protocol	Trying to remember exam forms/procedures taught in the clinic or classroom	*Just from our differential class*

One purpose of this research was to formulate an understanding of the effect of problem presentation on the clinical reasoning hypothesis categories physical therapy students generate. After the final codes were applied to the verbatim transcriptions, a count of each individual hypothesis category was made. These data were entered in a statistical software program (*IBM SPSS Statistics* Version 25.0.0.1) for analysis. Means with standard deviations were calculated for each hypothesis category followed by Mann Whitney-*U* comparisons to determine if these differences were statistically significant. After running the analysis, mean differences and effect sizes were manually calculated per the methodology. These data have been tabled (Table 4.3) and highlight the similarities and differences in clinical reasoning hypotheses participants generated during the problem-solving sessions

Table 4.3

Comparison of Reasoning Hypotheses

	Simulated Patient	Written Case Study	Mean Difference (r^2)
	M (SD)	*M* (SD)	
Health condition	7.33 (4.51)	14.5 (1.00)	**7.17 (.69)**
Anatomical structure	19.33 (10.69)	22.50 (5.45)	3.17 (.02)
Body functioning/ impairment	46.33 (14.57)	32.50 (9.00)	13.83 (.22)
Activity/Participation	4.67 (3.22)	10.75 (4.57)	6.08 (.37)
Contributing factors	29.33 (8.39)	22.5 (4.36)	6.83 (.07)
Client perspectives	2.67 (.58)	.25 (.50)	**2.24 (.71)**
Symptom characteristics	28.67 (4.73)	17.00 (4.97)	**11.67 (.64)**
Mechanism of injury	3.33 (1.53)	4.75 (2.63)	1.42 (.08)
Personal factors	4.67 (.58)	9.00 (1.83)	**4.33 (.70)**
Minimizing reasoning errors	18.33 (9.24)	2.00 (1.83)	**16.33 (.65)**
Phase	3.00 (1.73)	2.50 (1.00)	.50 (.03)
Precautions/Contraindications	5.33 (8.39)	3.00 (2.94)	2.33 (<.00)
Mgt./Tx. Considerations	2.00 (1.73)	6.00 (4.69)	4.00 (.30)
Follow protocol	1.33 (2.31)	1.00 (1.41)	.33 (<.00)

Note. Mean differences in bold are statistically significant at $\alpha<.05$

The hypothesis categories of health condition, client perspectives, symptom characteristics, personal factors, and minimizing reasoning errors were found to be significantly different between groups. Specifically, it was detected that dyads assigned to the simulated patient group generated significantly more clinical reasoning hypotheses regarding client perspectives, symptom characteristics, and minimizing reasoning errors, whereas hypotheses regarding health conditions and personal factors were generated significantly more by participants assigned to the written case study group. The mean differences among these hypothesis categories ranged from 2.24–16.33. However, other hypothesis categories had mean average differences higher than 2.24 but were not found to be significantly different. For instance, with a mean difference of 13.83, the hypothesis category body functioning/impairment was not found to be significantly different between groups. This was probably due to large standard deviations for simulated patient (SD = 14.57) and written case study (SD = 9.00) for the body functioning/impairment hypothesis category.

Effect sizes were found to be moderate-to-high for all significantly different hypothesis categories (r^2 = .64–.71). This means that 64%–71% of the variance between group means could be explained by the independent variable (i.e., simulated patient and written case study). Small-to-medium effect sizes were calculated for hypothesis categories that were not found to be significantly different between groups (i.e., activity/participation, body functioning/impairment, and management/treatment considerations). For instance, the hypothesis category activity/participation had a mean difference of 6.08 but was not found to be significantly different. However, it did have a small-to-medium effect size (r^2 = .37). This means that the independent variable accounted for 2.25 of the 6.08 mean difference score found between groups for activity/participation hypotheses.

Effect of case presentation on reasoning strategies. Reasoning strategies are defined as the organization of how to think and act in clinical practice (Jones et al., 2008). That is, as new clinical data is obtained, physical therapy clinicians organize their clinical reasoning hypotheses into patterns which regulates the next courses of action they take with their clients.

The results of this study identified nine different reasoning strategies implemented during the problem-solving sessions (Table 4.4). The finalized reasoning strategy categories were generated in consideration of the literature review and other sources that have described the clinical reasoning strategies implemented by expert and novice clinicians (Edwards et al., 2004a; Gilliland, 2017; Jones et al., 2018; Jones et al., 2008). The table is organized to provide the name of the reasoning strategy and their definitions used to apply codes to the verbatim transcriptions. The rightmost column provides an example from the verbatim transcriptions that represented each reasoning strategy.

Table 4.4

Reasoning Strategies

Code	Definition	Example
Trial and error	No plan or hypothesis established; Moving from one idea to another with no clear line of reasoning	*Because DVTs. But he has hypertension. Claudication?*
Rule-in/Rule-out	Rudimentary form of hypothetico-deductive reasoning; Hypotheses are supported or dismissed based on minimal test findings	*I don't think it's ACL. He doesn't have anything pointing to that*
Hypothetico-deductive	Generating and testing hypotheses; Includes both induction toward a general idea (e.g., pathology, or impairment) followed by purposeful deductive reasoning through the acquisition of new information	*Maybe arthritic changes, we haven't seen him walk, squat or how he's moving*
Reasoning about pain	Use of descriptors of pain along with aggravating and/or alleviating factors to guide thinking	*Sitting helps but begins to hurt after sitting too long, maybe he's sitting in too much knee flexion.*
Interactive reasoning	Reasoning for establishing positive client/therapist rapport	*Welcome to our clinic…I'm going to be your physical therapists today*

Table 4.4 (continued)

Code	Definition	Example
Reasoning about teaching	Reasoning for what and how relevant clinical content is delivered when educating clients	*Part of his education…when he feels his knee getting stiff…walk 5 minutes…so he's not in a stationary position for a prolonged period of time*
Narrative reasoning	Use of client stories to understand their illness experiences; Consideration for client expectations and beliefs when creating rehabilitation programs	*It says he wishes this would go away on its own; I was reading that too as far as motivation…*
Pattern recognition	Inductive process in which data analysis results in a hypothesis	*He has a high BMI, left knee pain, and age is a factor too. Osteoarthritis or something like that?*
Reasoning about procedure	Reasoning of the selection and implementation of tests and measures	*Do you just want to go into palpation now?*

Note. ACL = Anterior cruciate ligament; BMI = Body mass index; DVT = Deep vein thrombosis

Like the hypothesis categories, tabulations of the reasoning strategies were made for each verbatim transcription and analyzed. Means, standard deviations, and Mann Whitney-*U* scores were derived followed by manual calculations for mean differences and effect sizes per the methodology. These results are presented in Table 4.5.

Table 4.5

Comparison of Reasoning Strategies

	Simulated Patient	Written Case Study	Mean Difference (r^2)
	M (SD)	M(SD)	
Trial and error	.33 (.577)	0.00 (0.00)	.33 (.19)
Rule-in/Rule-out	5.00 (1.00)	4.25 (2.06)	.75 (.02)
Hypothetico-deductive	5.00 (1.73)	.25 (.50)	**4.75 (.71)**
Reasoning about pain	13.00 (8.89)	9.75 (2.75)	3.25 (<.00)
Interactive reasoning	.33 (.58)	0.00 (0.00)	.33 (.19)
Reasoning about teaching	0.00 (0.00)	1.50 (2.38)	1.50 (.25)
Narrative reasoning	0.00 (0.00)	.25 (.50)	.25 (.11)
Pattern recognition	1.00 (1.00)	6.75 (.96)	**5.75 (.65)**
Reasoning about procedure	25.67 (7.51)	5.25 (1.71)	**20.42 (.64)**

Note. Mean differences in bold are statistically significant at $\alpha<.05$

Through this analysis significant differences for hypothetico-deductive reasoning, pattern recognition and reasoning about procedure between groups were detected. Dyads assigned to the simulated patient group exhibited significantly more instances of hypothetico-deductive reasoning and reasoning about procedure whereas dyads in the written case study group exhibited significantly more instances of pattern recognition. Hypothetico-deductive reasoning relies on deductive patterns of cognition where the clinician formulates an initial hypothesis and then perform additional tests and measures that support or refute that hypothesis. Conversely, pattern recognition is a form of inductive reasoning whereby the clinician recognizes key clinical features of a case to quickly arrive at a diagnostic conclusion.

Moderate-to-large effect sizes were detected for hypothetico-deductive reasoning (r^2 = .71), pattern recognition (r^2 = .65), and reasoning about procedure (r^2 = .64) respectively. Unlike reasoning hypotheses, these reasoning strategies (i.e., hypothetico-deductive reasoning, pattern recognition, and reasoning about procedure) were found to have the largest mean differences among all the clinical reasoning strategies implemented by participants during the problem-solving sessions (Table 4.5). Effect sizes for reasoning strategies not found to be different between groups were interpreted as small or negligible.

Interestingly, four reasoning strategies were found to be implemented by one group only. The analysis detected trial and error reasoning and interactive reasoning were only exhibited by dyads assigned to the simulated patient group whereas reasoning about teaching and narrative reasoning were only exhibited by dyads assigned to the written case study group. Although not statistically significant from one another, the mere presence/absence of these reasoning strategies may have larger implications. For instance, dyads assigned to the written case study group considered how they would educate their client on their diagnosis and procedural interventions (i.e., reasoning about teaching) where no such consideration was made by participants assigned to the simulated patient group indicating that participants in the written case study group focused their thinking beyond arriving at a pathoanatomical diagnosis as instructed.

Effect of case presentation on reasoning errors. Reasoning errors are mis-judgments in thinking and understanding of a clinical problem that clinicians sometimes make. Errors in judgments can be due to multiple factors including mis-performing clinical tests and measures, mis-interpreting examination procedure findings, internal-biases, and not understanding the importance or relevance of clinical data at the time they're observed (Doody & McAteer, 2002). One purpose for this study was to formulate an understanding of the effect case method presentation on the reasoning errors physical therapy students make when working through a musculoskeletal clinical problem. The finalized reasoning error categories were generated in consideration of the literature review and other sources that have investigated and described the clinical reasoning errors made by expert and novice clinicians (Doody & McAteer, 2002; Gilliland, 2017; Jones, 2014). A total of seven types of reasoning errors were identified from the verbatim transcriptions (Table 4.6). This table provides the names of the finalized reasoning error categories, their definitions, and examples from verbatim transcriptions that represented each reasoning error. Many of these errors were identified through the verbalizations made and physical actions the study participants exhibited. Therefore, the table was formatted so that participant verbalizations are written in *italics* and their associated physical actions are written in narrative form and bracketed. The right most column of the table provides an example from the verbatim transcriptions that represented each error category.

Table 4.6

Reasoning Errors

Code	Definition	Example
Jumping to conclusions	Taking necessary but insufficient pieces of information and drawing a conclusion without consideration for other necessary information to draw that conclusion	*Golfing, bad mechanics for years* [No swing assessment made]
Perseveration	Continued rationalizing for a conclusion despite receiving information that runs counter to that conclusion	*I'm wondering if it's DVT* [After performing Homan's test for DVT and subjective inquiry]

Table 4.6 (continued)

Code	Definition	Example
Procedural error	Testing not performed properly	*I'm not 100% sure how to do this but you're pushing into varus right?* [Pushes into valgus]
Interpretation error	Results from tests are inaccurately expounded	[Misinterpreting results on standardized outcomes] (e.g., LEFS & WOMAC)
Disregard	Downplaying results of tests because of not recognizing their significance	*Yeah, I don't really put too much weight into those* [Regarding lower extremity flexibility testing]
Superficial psychosocial assessment	Client/therapist downplays presence of psychosocial/environmental factors, so they are assumed to be non-relevant	*Single story apartment, smokes two packs per day, that doesn't help*

Note. DVT = Deep vein thrombosis; LEFS = Lower Extremity Functional Scale; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index

The frequency of reasoning error codes from the verbatim transcriptions were calculated and analyzed. A comparison of means and standard deviations was made followed by Mann Whitney-*U* calculations for determining if the differences between groups were statistically significant. Lastly, manual calculations of mean difference and effect sizes were performed as per the methodology. The results of the statistical analysis have been tabled (Table 4.7)

Table 4.7

Comparison of Reasoning Errors

	Simulated Patient	Written Case Study	Mean Difference (r^2)
	M (SD)	M(SD)	
Jump to conclusions	1.00 (1.00)	1.75 (1.71)	.75 (.04)
Perseveration	.67 (1.16)	0.00 (0.00)	.67 (.19)
Procedural error	3.33 (2.52)	0.00 (0.00)	**3.33 (.78)**
Interpretation error	.67 (.578)	1.50 (1.73)	.83 (.02)
Disregard	0.00 (0.00)	2.75 (1.26)	**2.75 (.71)**
Superficial psychosocial assessment	.67 (.578)	.50 (.58)	.17 (.02)

Note. Mean differences in bold are statistically significant at $\alpha<.05$

The analysis detected significant differences for procedural error and disregard between groups. Dyads assigned to the simulated patient group made significantly more procedural errors whereas dyads assigned to the written case study group exhibited significantly more instances of downplaying clinical results because of not understanding their value at the time they were observed. The effect size of case presentation method was found to be moderate-to-large for both procedural error (r^2 = .78) and disregard (r^2 = .71). Upon further inspection it was noted that dyads assigned to the simulated patient group did not exhibit a sense of disregard for the data they collected. This makes sense because participants in the simulated patient group selected those tests and measures they identified that would assist them in determining an accurate diagnostic conclusion and therefore would be less likely to ascertain such findings as insignificant. Conversely, we found that dyads assigned to the written case study group did not exhibit procedural errors during the problem-solving sessions. Again, this makes sense as participants in the written case study group did not have to perform any clinical tests and measures therefore, they could not perform those skills inaccurately. However, dyads in the written case study group did exhibit significantly high instances of disregard. This maybe because they were presented with large chunks of case findings at pre-determined intervals. These large chunks of clinical data may have overwhelmed participants leading them to downplay or just not recognize their significance at times.

Qualitative Profile

In addition to quantitative comparisons, a qualitative approach to data analysis was performed. The purpose of this approach was to enrich findings from data set by highlighting concepts that quantitative analysis could not capture. The qualitative profile was created in two steps per the methodology. To enhance credibility of the findings, a peer debriefing process for the proposed qualitative themes was undertaken. After this review, two themes were retained and are presented here.

Regulation of learning. When individuals are engaged in learning tasks they can self-monitor their progress toward the task goal. One-way individuals regulate their progress toward task goals is by evaluating, monitoring and controlling those variables that facilitate or impede their progress (Schoor, Narciss, & Körndle, 2015). For instance, learners can regulate specific domain knowledge (Greene & Azevedo, 2007). When a learner identifies they lack the needed knowledge to advance toward task related goals a corrective action such as study strategies may be developed and implemented (Schoor et al., 2015).

After reviewing the verbatim transcriptions, it was identified that participants in both case presentation groups exhibited regulation of learning. This was exemplified in verbalizations such as, “I’m not sure how to do that,” or “I can’t remember the psychometrics of that”. These examples make explicit that the physical therapy student was unknowledgeable of necessary information at the time it was needed during their clinical reasoning. Interestingly, although both groups demonstrated regulation of their knowledge during the problem-solving sessions, each group generally regulated different types of knowledge.

Clinical reasoning has been defined as the application of both cognitive and psychomotor skills (Atkinson & Nixon-Cave, 2011; James, 2007). That is, not only do physical therapy clinicians need to know what tests to perform in any given situation, they must also know how to perform and interpret them appropriately. After reviewing the verbatim transcriptions, it was determined that participants assigned to the simulated patient group regulated more psychomotor knowledge whereas participants assigned to the written case study group regulated more propositional knowledge.

The following example highlights regulation of psychomotor knowledge by participants, Lily and Asher (pseudonyms), assigned to the simulated patient condition. This example begins with Lilly and Asher deciding to perform the Varus and Valgus Stress Tests at the knee while working with the simulated patient:

Asher: Do you want to do like the varus and valgus?

Lilly: Yes, I do.

Asher: I’m not 100% sure how to do this but you just push into varus right? [Attempts to perform Varus Stress Test]

Lilly: How about… [Walks over to Asher and simulated patient; changes Asher’s hand contacts and body position to perform Varus Stress Test appropriately].

Asher: OK.

In this example, Asher generated a hypothesis regarding the surrounding knee ligaments as potential pain sources and wanted to test their integrity. Together, Lilly and Asher decided that the Varus and Valgus Stress Tests at the knee should be performed to test this hypothesis. However, Asher made a procedural error by performing the Varus Stress Test with improper positioning and hand contacts. Fortunately, Lilly was present to correct Asher's form and they were able to obtain more reliable clinical data for their clinical reasoning. This was an example where Asher was knowledgeable of the clinical tests needed to ascertain the integrity of the surrounding knee ligaments (propositional knowledge) but was unsure how to perform them (psychomotor knowledge). Asher was afforded the opportunity to have her body positioning and hand contacts corrected which led to an understanding that her initial conceptualization for performing the Varus Stress Test was incorrect and her performance will need modification to perform the test correctly in the future.

Conversely, participants in the written case study group had more instances of regulating propositional knowledge. In the following example, Bailey and Amy (pseudonyms) were just provided with background information that included the patient's height and weight. Amy begins generating hypotheses regarding this information specifically how the patient's height and weight are calculated to obtain a body mass index (BMI) score:

Amy: I don't know the BMI exactly, I don't know how to calculate it.

Here we see that Amy has acknowledged that she is unknowledgeable of how to calculate a BMI score even if the patient's height and weight are known. However, in this case Bailey and Amy were able to generalize that a person who is 6 foot 2 inches tall, with a body weight of 260 pounds could be considered a larger individual. They use this information to generate further hypotheses in the following exchange:

Amy: My initial thoughts are somewhere along the lines of something like arthritis.

Bailey: Overuse, something to ask about, yeah history of activities, sport's he's played.

Here, Amy exhibited forward reasoning when she inductively reasoned that a patient's height and weight are considerable risk factors for developing degenerative joint diseases, especially in the lower extremities. Bailey interjects ways they could obtain further clinical data from the patient to support or refute this hypothesis.

In another exchange, Amy and Bailey were provided with information regarding the results of varied special tests for their patient. Amy once again is considering the significance of a positive finding on the Apley's Compression Test, a special test designed to assess the integrity of the menisci in the knee.

Amy: Yeah. I mean he's got a lot of different, he's got the crepitus, I mean, the Apley's being with a meniscal, that's supposed to be a meniscal thing but I'm I don't entirely remember all the psychometrics for it but when you're putting compression through the knee.

Here, Amy exhibits a rudimentary understanding of the Apley's Compression Test. That is, she knows about the test and its role for assessing the integrity of the menisci of the knee. However, she recognizes that she is not as knowledgeable of its clinical utility (e.g., sensitivity and specificity). Without this knowledge Bailey and Amy are only able to interpret this examination finding in a superficial way as demonstrated in the following exchange:

Bailey: Pushing through something that doesn't have a lot of cushioning there, if we're thinking osteoarthritis

Amy: Yeah so, an Apley's compression doesn't tell me…

Here we see that without a good understanding of the clinical utility of the Apley's Compression Test, Amy and Bailey were unable to use this finding in a meaningful way to support the presence of meniscal pathology for the simulated patient. We do see that Bailey and Amy were still considering osteoarthritis as a potential diagnosis for their patient with Bailey interpreting the positive Apley's Test finding as impaired menisci contributing to the progression of knee osteoarthritis.

These exchanges highlight a few instances of learning regulation study participants displayed during their clinical reasoning. While participants did not solely regulate propositional knowledge or psychomotor knowledge across groups it was found that participants assigned to the simulated patient group generally regulated more psychomotor knowledge whereas written case study participants regulated more propositional knowledge.

Timing of treatment considerations. The second theme identified after careful inspection of the research data was differences in the timing of treatment considerations between groups. Most notable was that participants assigned to the written case study group began to consider how they would treat their patient before receiving all the clinical data from the written case study. In fact, regarding dyads assigned to the simulated patient group, only one instance of treatment consideration was made during the problem-solving sessions whereas all four dyads assigned to the written case study group incorporated treatment considerations during the diagnostic reasoning process. This was exemplified by verbalizations such as "I can think already of a few things to do" and "what that does for me is it changes my treatment strategy". This finding is most interesting because each dyad was instructed to use case findings for determining a diagnostic conclusion and were not prompted to reason about treatment strategies for the patient.

Only one instance of treatment consideration for dyads assigned to the simulated patient group was noted. In this example, Vera and Jennifer (pseudonyms) were nearing the end of the problem-solving session when they were considering their observation of flat feet as a potential contributor to their patient's knee pain:

> **Jennifer:** I'm just thinking like if his foot is so flat…He's going to have pain because of that…Just maybe getting him into a better alignment or something would just help a lot. Give him support so he's not in a constant strain.
>
> **Vera:** The thing is like looking at him, his strength is good and so like if we were going to treat him like it's not going to be a strength thing. I mean unless it's a coordination thing. Like he has poor coordination.

Here, Jennifer was thinking about how altering the patient's lower extremity alignment could offload the painful knee for reducing symptoms and improving function. Vera interjects thoughts about implementing exercises designed to improve motor coordination of the lower extremity for offloading the painful knee. This was the only example of physical therapy treatment consideration made by any of the dyads assigned to the simulated patient group. All other treatment/management hypotheses generated by participants in the simulated patient group were made in consideration for the need of a possible referral to another healthcare practitioner.

Conversely, it was found that all four dyads assigned to the written case study group generated hypotheses regarding treatment for their patient during the diagnostic reasoning process. Additionally, every dyad did so before receiving all available findings provided by the written case study. For instance, Amy had already considered having enough clinical data to treat their patient before receiving clinical data regarding special tests, gait analysis, performance measures and standardized outcome measures:

Amy: So, between selective tissue tension testing, mobility testing, and then putting numbers to it with the goni, we have some capsular restrictions at the ankle. All right so I would say as far as a threshold to treat I think we have enough.

This is very interesting because it implies that Amy does not necessarily consider an accurate diagnostic label *a priori* for providing interventions to clients seeking physical therapy services. Instead, Amy has linked several body functioning/structure impairments commonly treated by Physical Therapists to their patient's current disability. This early recognition for the need for physical therapy intervention led to future considerations for important education they would provide their client:

Amy: As far as psychosocial components. I mean it says he wishes this would go away on its own.

Bailey: I was reading that too as far as motivation and...

Amy: Yeah, motivation and then it's going to be real important in our education. That if we do think these are arthritic changes, that there's nothing we're going to do that takes away his arthritis, but we can still work on the impairments that exist and see how they modulate his symptoms and allow him to keep golfing and working.

Bailey: Probably need to cut down as far as his diet, smoking, and the beers daily to help bring down some of the inflammation if he's…

Amy: Yeah, inflammatory diet, if we can decrease his weight and that joint stress…

Bailey: Yeah

We now see Amy and Bailey considered their clients personal goals (i.e., golfing and working without pain) and personal factors (i.e., smoking, daily alcoholic consumption, and body weight) to individualize the education they would provide this patient. These exchanges exemplify a biopsychosocial perspective of healthcare inclusive of biological factors (e.g., ankle mobility) with psychosocial factors (e.g., motivation, and daily health habits) in the care of their patient. A perspective not observed in Jennifer and Vera's treatment considerations.

In another example, Edgar and Gerald (pseudonyms) also reasoned about how they would educate their client in improving the daily health habits of their client:

> **Edgar:** And I think a lot of education that first time. What's going on, why are we looking at…
>
> **Gerald:** Especially if he's diabetic too. The foot, foot care is…
>
> **Edgar:** I think education on health, weight, the smoking, the diabetes. How that all contributes in a respectful manner.

Additionally, Edgar and Gerald also reasoned about one of their client's personal goals for seeking out physical therapy services, improved tolerance for driving long distances and time frames:

> **Gerald:** And then eventually a goal for him is to be able to…
>
> **Edgar:** Drive with less pain
>
> **Gerald:** …drive with less pain
>
> **Edgar:** …his left leg he can move that in the car. So, if it's getting stiff and he's just keeping it there, you can educate on just moving it around a little while he's driving.

In this exchange we see Edgar and Gerald reason how they would educate their patient in reducing the amount of stiffness they have when driving for longer distances and periods of time. This treatment consideration was inclusive of one of the patient's personal reasons for seeking physical therapy services. Gerald and Edgar could've easily focused on reducing stiffness as a goal for their physical therapy treatment (biological factor) but instead choose to frame this treatment consideration around their patient's personal goal (psychosocial factor).

All other instances of treatment considerations made by dyads assigned to the written case study group were made before receiving clinical data regarding standardized outcome measures. These outcome measures typically provided information regarding a patient's current level of functioning and symptoms experienced while performing functional movements (e.g., walking, climbing stairs, and squatting). Again, this exemplifies that these physical therapy students did not consider an accurate diagnostic label necessary to consider physical therapy interventions they would implement with their patient.

As mentioned previously, the quantitative analysis determined that participants in the simulated patient group exhibited no instances of reasoning for teaching their patient. This was largely because these participants spent all their allotted time performing tests and measures to arrive at a diagnostic conclusion. Conversely, participants in the written case study group made considerably more treatment considerations and reasoning about teaching during the problem-solving session. Patients seeking out physical therapy services undergo a thorough examination process to ascertain if the causes of the patient's pain and dysfunction are within the therapist's scope of practice to treat (American Physical Therapy Association, 2014b). Participants in the written case study group appeared to reach an acceptable level of confidence for initiating a physical therapy treatment program for the patient based on the clinical data provided and therefore, may have decided that obtaining an accurate diagnostic conclusion was no longer paramount to providing procedural interventions that would assist the patient toward recovery.

The purpose of creating a qualitative profile was to enrich the data set and expand upon the conclusions made through quantitative analysis. A total of two qualitative themes were retained after peer-review enhancing the credibility of the qualitative profile's findings. These findings highlighted differences of learning regulation and timing of treatment considerations between groups. It was observed that participants assigned to the simulated patient group regulated more psychomotor knowledge whereas participants assigned to the written case study group regulated more propositional knowledge and were more considerate of patient treatment in their clinical reasoning.

Chapter 5: Discussion and Implications

This chapter presents a discussion of the research findings as it relates to the main research questions– *What effect does case-presentation have on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when working through a musculoskeletal clinical problem?* Talk-aloud methodology was implemented for collecting data and creating verbatim transcriptions to observe the cognitive processes physical therapy students exhibited while engaged in the clinical reasoning process. This discussion draws from the quantitative and qualitative results from chapter 4 framed through the conceptual lenses of Marton and Säljö's (1976) levels of engagement (*surface-level* and *deep-level*), the goal-focusing model of McCrudden et al. (2010), cognitive load theory, and Alexander's (2004) Model of Domain Learning.

Levels of Processing and Goal Focusing

Research has identified that students exhibit different levels of cognitive processing in their learning from reading texts (Marton & Säljö, 1976). For instance, *superficial-level* processors implemented learning strategies like memorizing as much as the text as possible for completing an assignment or an examination. Conversely, learners who displayed *deep-level* processing implemented strategies that assisted in fully understanding the authors intention for writing the texts. That is, what conclusions did the author want the reader to draw from their writing, or in other words what was the authors purpose for writing the text to begin with. Similarly, clients seeking physical therapy services attempt to convey their personal illness stories to their therapists. These stories typically include variables that the client feels are pertinent to fully understand their problem and their personal goals for physical therapy treatment. Edwards et al. (2004a) described narrative reasoning as the comprehension of client illness stories inclusive of personal factors such as culture, personal beliefs, and situational context. Therefore, narrative reasoning necessitates physical therapy practitioners be considerate of psychosocial factors in addition to biological factors contributing to their client's current level of disability. Additionally, they observed dialectical thinking in expert physical therapists. They defined dialectical thinking as a physical therapist's ability to move between traditional empirico-analytical thinking closely associated with biological factors and interpretive thinking closely associated with narrative reasoning inclusive of psychosocial factors.

Recently, several calls for healthcare professionals including Physical Therapists to adopt a biopsychosocial perspective of health when working with clients have been made (Jones et al., 2018; Jones et al., 2008; World Health Organization, 2001). A biopsychosocial perspective of health requires healthcare practitioners to attend to psychosocial factors such as the client's physical environment, socioeconomic status, mood, and motivation in addition to biological factors such as their strength, and range-of-motion contributing to their current level of disability. It has been stated that physical therapists are generally good at attending to biological factors but need to be better focusing on psychosocial factors affecting their clients functioning (Jones et al., 2018). Therefore, it could be said that physical therapists who focus on biological factors and downplay or ignore the significance of psychosocial factors contributing to their client's level of disability display a *superficial-level* of reasoning whereas physical therapists who address and incorporate psychosocial factors in the care for their clients could be said to be displaying *deep-level* reasoning. Now, it is important to note that in marking a physical therapy clinician's clinical reasoning superficial, I do not mean to imply that their clinical reasoning or for that matter the physical therapy services they provide are at a level of incompetence. Quite the contrary in fact. It takes years of doctoral level education to develop the knowledge comprehension and psychomotor skills needed to work at an entry-level of capability in physical therapy practice. In other words, if psychosocial factors are important to address to achieve the best possible outcomes for our clients, then as educators we should be providing educational experiences that facilitate deep-level reasoning skills such as narrative and dialectical reasoning.

Interestingly, a significantly higher number of instances of hypothesis generation regarding personal factors from dyads assigned to the written case study group was identified compared to the simulated patient group (Table 4.3). Additionally, the qualitative profile detected instances where dyads assigned to the written case study group were considerate of their client's psychosocial factors in their treatment considerations. For instance, I previously presented an exchange between Amy and Bailey (pseudonyms) discussing treatment options they would consider implementing with the simulated patient. In this exchange, Amy and Bailey considered their client's motivation level to get better, and daily health habits such as smoking and daily consumption of alcoholic beverages. They specifically considered these variables in the education they would provide if they were really working with this client in the clinical setting. By paying attention to these psychosocial factors in addition to biological factors such as diminished ankle range-of-motion, Amy and Bailey displayed deep-level reasoning processing. In another example, Edgar and Gerald (pseudonyms) who were assigned to the written case study group incorporated the client specific goal of improving driving tolerance in their treatment considerations. Specifically, they reasoned about how they would educate their client in modifying their driving positioning and posture to reduce the amount of stiffness and pain their client was having with longer drives. Conversely, we found only one dyad from the simulated patient group who incorporated treatment considerations during their diagnostic reasoning. In this instance, Jennifer and Vera did not consider any possible psychosocial factors they would address with their client. Instead they wholly focused on biological factors such as posture, strength, and motor coordination indicative of superficial-level reasoning.

With an understanding for differences in levels of reasoning the study participants displayed, I will now discuss how environmental factors, specifically case presentation method, affected physical therapy student self-determined goals for the problem-solving session and how these influenced their cognitive processing strategies, and learning. Previously, I discussed a goal-focusing model (Figure 2.2) that depicts how given and personal intentions affect learner goals, processing, and learning (McCrudden et al., 2010; McCrudden & Schraw, 2007). According to the goal-focusing model, personal intentions are the criteria students hold themselves to in their learning. For this research, personal intentions may include the level of confidence a physical therapy student needs to have before drawing a diagnostic conclusion or perhaps what comprises a “good” physical examination. For instance, when selecting examination procedures to perform, physical therapy students may select tests and measures they have more confidence in performing rather than other better tests they are less comfortable performing or interpreting.

Personal intentions can vary widely between individuals. The study participants of this research were all third-year students at the same level of progress in their professional education program. This means each participant was exposed to similar didactic learning experiences that cultivated their propositional and psychomotor knowledge for the physical examination tests and measures they would perform. Therefore, personal intentions were considered similar among participants for discussing the research findings.

Given intentions on the other hand are environmental factors such as teacher instructions, and situational context of educational experiences. In this study, participants were given two primary given intentions. First, was to reason through the case findings to arrive at a diagnostic conclusion. Both groups received this given intention. Second, each dyad was exposed to either the simulated patient or written case study condition.

According to the goal-focusing model, when personal intentions interact with given intentions, learners develop goals for the educational experience. Again, I considered the personal intentions among participants to be similar and each group was assigned with the task of determining an accurate diagnostic conclusion. Therefore, the only factors influencing participant self-determined goals in this study considered was the situational context (i.e., case method presentation) each group was exposed to. While it is possible that differences in self-determined goals may affect student information processing, I am going to table this discussion for a moment as it will be easier to understand after having a good understanding of the differences in information processing each group of physical therapy students exhibited in this study.

According to McCrudden et al. (2010), students process information from a learning task that they feel are relevant to achieving their self-determined goals which are influenced by personal and given intentions (Figure 2.2). In this research the clinical reasoning hypotheses generated, strategies implemented, and level of reasoning (i.e., deep or superficial) were the cognitive processes physical therapy students exhibited for achieving their self-determined goals. I have already discussed the differences in processing levels between physical therapy students assigned to the simulated patient and written case study groups in the previous section. I will now discuss differences in clinical reasoning hypothesis and strategy categories between groups that may have been influenced by given-intentions and self-determined goals.

Quantitative findings identified significant differences between groups in three clinical reasoning strategy categories–hypothetico-deductive reasoning, pattern recognition, and reasoning about procedure (Table 4.5). Hypothetico-deductive reasoning is a deductive reasoning strategy whereby a clinician collects initial data, generates an initial list of potential problems that could be causing the patients symptoms, and performs tests that will assist in supporting or refuting each identified potential problem. In contrast, pattern recognition is an inductive reasoning strategy whereby clinicians identify key features of a case to promptly come to a diagnostic conclusion.

The analysis indicated that physical therapy students assigned to the simulated patient group exhibited significantly more hypothetico-deductive reasoning strategy whereas those assigned to the written case study group exhibited significantly more instances of pattern recognition strategy. The goal-focusing model assists to explain two plausible reasons for these findings. First, was the nature of the given intention. For instance, physical therapy students assigned to the written case study group were provided all relevant key examination findings in an organized and stepwise process per the methodology. With access to all the relevant clinical data at their fingertips, these participants were well positioned to inductively identify those key features of the case that assisted them in drawing a diagnostic conclusion. On the other hand, participants in the simulated patient group only received relevant clinical data when they performed select tests and measures on the actor. That is, these participants had to piece together incomplete data which led to generating initial impressions of the problem and conducting further testing to support or refute that hypothesis. Therefore, the independent variable itself was the causative factor for this difference. The effect sizes for hypothetico deductive and pattern recognition was found to be moderate-to-strong, calculated as $r^2 = .71$ and .65 respectively.

Additionally, it was concluded that participants assigned to the simulated patient group displayed significantly more instances of reasoning about procedure compared to the written case study group (Table 4.5). This finding was not surprising as the nature of the simulated patient given intention required those participants to decide the tests and measures they wanted to perform and how to sequence them as they received new clinical data. In fact, this reasoning strategy had a mean difference of 20.42 between groups with a moderate-to-large effect size (r^2 = .64). This mean difference was the largest out of all the clinical reasoning hypothesis and strategy categories in this study.

Furthermore, the hypothesis category minimizing reasoning errors was found to significantly differ between the groups and had the second largest mean difference of all hypotheses generated and strategies implemented (Table 4.5). Like reasoning for procedure, this finding is accounted for by the given intention of simulated patient. These participants would typically justify the need for further testing to support or refute their current thinking regarding the case problem.

Second, could be differences in the self-determined goals each group created based on the given intention (i.e., simulated patient or written case study). For instance, it's possible that participants in the written case study group all developed similar self-determined goals of identifying possible treatment considerations throughout the diagnostic reasoning process, whereas all participants assigned to the simulated patient group did not. However, every dyad regardless of group assignment was instructed that the purpose of the clinical reasoning interaction was for determining an accurate diagnostic conclusion. This given intention should have swayed participants in the written case study group away from generating such a goal for the problem-solving session, however, since this research did not investigate participant self-determined goals it cannot be completely ruled out as a reason for the differences in reasoning processes implemented between groups.

The final output of the goal-focusing model is learning. The clinical reasoning process has been closely linked with metacognition, a cognitive skill of self-awareness that assists learners translate cognition into new knowledge (Higgs & Jones, 2008). Reflective thinking, a metacognitive skill whereby the learner self-evaluates their thinking and decision making is considered a core dimension of clinical reasoning capability in physical therapy practice (Christensen & Jensen, 2018; Christensen et al., 2008). Reflective thinking is typically exemplified through reflection-in-action and reflection-on-action whereby the clinician regulates their thinking and progress in the problem task and adjusts their thinking and decision making accordingly (Schön, 1987). The qualitative profile identified regulation of learning took place among student participants but in two different ways. That is, participants assigned to the simulated patient group exhibited more instances of regulating psychomotor knowledge whereas those assigned to the written case study group exhibited more instances of regulating propositional knowledge. This may be explained by the given intention, case method presentation, assigned to each group. For instance, participants assigned to the simulated patient group not only had to decide which tests and measures to conduct, but also had to perform them. We found multiple instances where participants questioned their partner on how to perform selected tests and measures or like in the example of Asher and Lilly (pseudonyms), one participant began performing the test incorrectly and their partner provided scaffolding for how to perform the selected test procedure correctly.

This discussion highlighted differences in the reasoning levels and processing that physical therapy students exhibited in this study. Regarding levels of processing, I described superficial-level reasoning as thinking that is mostly or wholly considerate of biological factors with minimal or no consideration for psychosocial factors known to contribute to a person's level of disability. In contrast, deep-level reasoning is exemplified when clinicians truly consider their client's personal, and/or psychosocial factors that facilitate or act as barriers to attaining an optimal level of health. The results of this study found that physical therapy students assigned to the written case study demonstrated significantly more hypotheses regarding personal factors with moderate-to-large effect size and displayed instances of incorporating psychosocial factors in their treatment considerations. Therefore, it appears written case method presentation may be a more ideal choice for facilitating deep-level reasoning in physical therapy students.

Additionally, I described the goal-focusing model of McCrudden et al. (2010), to understand the reasoning strategies physical therapy student participants made during the problem-solving sessions. It was found that participants assigned to the simulated patient group exhibited significantly more instances of hypothetico-deductive reasoning and reasoning about procedure whereas those assigned to the written case study condition exhibited significantly more instances of pattern recognition with moderate-to-large effect sizes. Therefore, implying the independent variable explained a large percentage of the variance in reasoning strategies between these groups. Therefore, if the physical therapy educator's goal is to facilitate acquisition of initial illness scripts typically seen in expert clinicians (Doody & McAteer, 2002), written case study may be the better choice of case presentation. On the other hand, if the educator's goal is to provide an educational experience that more closely mirrors clinical practice and facilitates needed hypothetico-deductive reasoning skills that novice clinicians typically rely on early in their careers (Doody & McAteer, 2002; Gilliland, 2014; Hendrick et al., 2009), then simulated patient experiences may be a better option.

Effect of Cognitive Load on Student Reasoning

Cognitive load is a concept concentrated on the effects of the inherent nature of learning tasks and how they are presented on student learning. The theory posits that learning occurs when information processed in working memory is synthesized into long term memory. While cognitive load theory recognizes an unlimited capacity for long term memory implying human learning is boundless. Working memory on the other hand, has a limited capacity and is subject to overload which adversely affects an individual's ability to learn. According to cognitive load theory, extraneous load are modifiable variables of the learning task whereas intrinsic load is unmodifiable and represents the inherent nature of the learning task itself (Sweller et al., 2011; Sweller et al., 1998). Lastly, germane load is the capacity needed to synthesize cognition from working memory into long term memory. According to cognitive load theory, a person experiences cognitive overload when the summation of extraneous, intrinsic, and germane load exceeds their working memory capacity.

In this research participants were subject to different levels of extraneous and intrinsic loads. Regarding extraneous load, participants assigned to the simulated patient group were instructed that they had to physically perform those tests and measures they deemed necessary to obtain relevant clinical data. This required them to work within a physical environment that included operating a mechanical treatment table, use of towels, and pillows as appropriate, and work with an actor of a specific body shape and size. Each of these factors are modifiable in nature. For example, the chosen actor could've been someone smaller and easier to manipulate for performing tests and measures on, or the type of mechanical table used could've been changed to an easier one to operate. On the other hand, participants assigned to the written case study group were provided with written clinical data separated over several typed pages and provided new clinical data at predetermined intervals if they were ready for them or not. This required them to sometimes flip through multiple pages of clinical data to find the information they sought. Each of these environmental factors were considered extraneous load because each were decisions made by me and could've been modified.

Intrinsic load on the other hand, are unmodifiable factors inherent to the learning task (Sweller et al., 1998). Regarding intrinsic load, significant differences in the inherent nature of the simulated patient and written case study experiences existed. For instance, participants assigned to the simulated patient group were only provided with minimal background information and any other clinical data they wished to collect had to be done so actively. Because of this, all three dyads decided to conduct an initial subjective interview to obtain further information for informing the physical tests and measures they would conduct on the actor. This process required participants to consider what questions to ask, and in what order to ask them. Additionally, as they collected this new information, the participants needed to commit this information to memory or undertake the extra task of written them down. Without a subjective interview these participants would've been flying blind in the early stages of their physical examination. Therefore, a subjective interview became an inherent component of the simulated patient problem-solving task. On the other hand, participants in the written case study group were provided with a thorough account of the subjective history of questions and their answers written on paper. This eliminated the need to consider questions to ask or memorize their answers as this information was provided in text. This is one example of intrinsic load for participants assigned to the simulated patient group being higher than participants assigned to the written case study group.

The differences in extraneous and intrinsic load experienced by each group significantly influenced the reasoning hypotheses generated, strategies implemented, and errors each made. Concerning reasoning errors, participants assigned to the written case study group had significantly more instances of disregarding pertinent information for drawing a diagnostic conclusion. This may be because of how the clinical data was provided to them. That is, these participants were provided with a significantly large amount of clinical data at predetermined time intervals. In fact, sometimes participants did not complete reviewing all previously provided clinical data before being handed more. This may have caused participants to simply downplay some of the relevant clinical data because they were processing too much information too quickly. On the other hand, participants in the simulated patient case had to decide for themselves what clinical data they wanted to obtain and perform appropriate subjective and objective testing to acquire it. Therefore, these participants may have considered all clinical data they tested for as pertinent to the case findings and did not exhibit any instances of disregard error. However, the need to physically perform tests and measures led to a significantly higher number of instances in procedural errors made in this group. Again, this is explained by the inherent nature of the simulated patient encounter that required participants to physically perform all the physical tests and measures whereas this was not expected from participants assigned to the written case study group. In fact, because of this, no instances of procedural error were identified from dyads in the written case study group. Additionally, moderate-to-large effect sizes were calculated for procedural error $r^2 = .78$, and disregard $r^2 = .71$ lending further support that differences in the inherent nature of the tasks (i.e., intrinsic load) for each case method presentation, significantly contributed to the types of errors each group made.

When first considering the potential effects of case presentation on physical therapy students' clinical reasoning I made a few hypotheses of expected findings. These hypotheses were made in consideration of the differences in cognitive load I expected each case presentation method to have on the participants. First, I hypothesized that participants assigned to the written case study group would generate and implement significantly more reasoning hypotheses and strategies. However, when comparing means for each hypothesis and strategy category between groups it was found that participants assigned to the simulated patient group generated more reasoning hypotheses and implemented more reasoning strategies. This was surprising because it was believed that without needing to perform physical tests and measures, participants assigned to the written case study group would be subject to lower levels of cognitive load and have more available working memory capacity to produce reasoning hypotheses and strategies. Instead, participants assigned to the written case study group exhibited significantly more pattern recognition strategy. This form of reasoning features identifying key clinical features of a case early on and may have precluded the need for generating additional alternative reasoning hypotheses and strategy implementation by these participants.

Second, I hypothesized that participants in the simulated patient group would exhibit significantly more reasoning errors. Again, this was because of the higher cognitive load I expected for these participants. However, it was found that both groups exhibited very similar instances of reasoning errors. Significant differences in the types of reasoning errors each group made were identified though. That is, participants assigned to the simulated patient group made significantly more procedural errors whereas participants assigned to the written case study group had significantly more instances of disregarding relevant key examination findings. Perhaps the cognitive load for participating in a simulated patient experience was not as high as originally expected and therefore did not cause higher incidences of errors for this group as expected.

It was also hypothesized that due to higher expected cognitive load for participants in the simulated patient group that they would exhibit more instances of the higher reasoning strategies– hypothetico-deductive reasoning and pattern recognition. Instead it was found that the simulated patient group exhibited significantly higher number of instances of hypothetico-deductive reasoning whereas the written case study group implemented significantly more instances of pattern recognition. This is likely due to the written case study condition being more conducive to locating and pulling key clinical features that fit illness scripts that were predeveloped by the student participants in this group.

Cognitive load theory has assisted in understanding the effect environmental factors and inherent attributes of the learning tasks influenced the reasoning strategies and errors produced by the participants in this study. Extraneous cognitive load are those modifiable factors such as the environment and educator instructions that shape the learning task. For instance, in other studies that investigated the reasoning hypotheses generated, strategies implemented and errors made by physical therapy students during a simulated patient encounter used verbal reports in lieu of requiring participants to actually perform the tests and measures on the actor (Gilliland, 2017; James, 2007). These factors change the cognitive load participants must attenuate which effected their clinical reasoning processes.

Clinical Reasoning Domain Learning

According to the Model of Domain Learning, students may develop competence in a domain area if they acquire an adequate level of propositional knowledge, strategies to implement that knowledge, and develop an increasing interest in that domain area (Alexander, 2004). Additionally, the Model of Domain Learning separates competency into early, middle, and late levels. In this study, participants were selected from a pool of subjects who all completed their required musculoskeletal/orthopaedic component of the didactic portion of their professional education program. This education facilitated propositional and psychomotor knowledge deemed necessary for providing orthopaedic physical therapy care to clients. Therefore, it was assumed each subject had acquired similar levels of propositional knowledge and knew appropriate strategies for providing orthopaedic physical therapy to clients. However, regarding level of interest for orthopaedic physical therapy, it was found that a larger percentage of participants assigned to the written case study group identified orthopaedics as an area of interest compared to participants in the simulated patient group. The Model of Domain Learning posits that these students are therefore more likely to develop higher levels competency (middle or late) in orthopaedic physical therapy.

Pattern recognition is a form of inductive reasoning that allows clinicians to quickly identify key clinical features of a case to draw a diagnostic conclusion. Typically, considered a reasoning strategy implemented by experts (Boshuizen & Schmidt, 2018; Doody & McAteer, 2002; Edwards et al., 2004a), other research has observed pattern recognition strategy implemented by physical therapy students (Gilliland, 2017; Gilliland & Wainwright, 2017). The findings from this research identified participants assigned to the written case study group exhibited significantly more instances of pattern recognition strategy compared to the simulated patient group. It's possible that due to more participants assigned to the written case study group identified orthopaedics as an area of interest in physical therapy, they had already begun to develop rudimentary *illness scripts* for common musculoskeletal pathologies. These illness scripts may have allowed them to implement more instances of pattern recognition strategy that was identified through quantitative analysis.

The Model of Domain Learning explains why learners develop the level of domain knowledge that they do. Alexander (2004) stated that acquiring certain levels of propositional knowledge, strategies for implementing that knowledge, and level of interest all promote achieving higher levels of domain learning. This study investigated participants at the same point of progression in their professional education programs. Demographic findings identified a difference in level of interest for orthopaedic physical therapy between groups. A higher percentage of participants assigned to the written case study group self-identified orthopaedics as an area of interest in physical therapy practice. Interestingly, it was this group that exhibited a significantly higher number of instances of pattern recognition strategy. This strategy requires clinicians to identify key clinical features of a case to inductively arrive at a diagnostic conclusion. This process is only possible after the learner begins to develop illness scripts in their long-term memory for recall later. It’s possible that students who self-identified orthopaedics as an area of interest in physical therapy may had already begun to develop an illness script for osteoarthritis, the musculoskeletal condition that the clinical case portrayed.

Implications

The following sections present implications for future research, practice, and leadership. First, implications for future research will be discussed. This section focuses on the need for more larger scale studies and studies regarding the effects of other commonly implemented instructional strategies for facilitating physical therapy student clinical reasoning skills. Second, implications for my practice as an educator and researcher will be discussed. This section will detail the impact this research project has had on the educational experiences I currently provide for my students and the need for continued inquiry into clinical reasoning for continued implementation of contemporary best educational practices in the classroom. Lastly, implications for myself as an educational leader will be discussed. Specifically, how this research project has facilitated three capabilities that educational leaders need for providing learner-centered education (Robinson, 2013).

Implications for future research. Regarding future research this project only provided insight into how case-method presentation effects clinical reasoning processes in physical therapy students from a small physical therapy program located in northeast Florida. More large scale, multi-institutional studies are needed for generalizing these findings to the larger population. Additionally, this research only compared two forms of case-method presentation on the reasoning processes of students. For instance, high-fidelity computer simulations have been endorsed for promoting student learning in health professional education programs (Silberman, Litwin, Panzarella, & Fernandez-Fernandez, 2016; Wellmon, Lefebvre, & Ferry, 2017). The effects of high-fidelity simulations as well as other case presentation methods are warranted to develop a fuller understanding for how pedagogic decisions effect clinical reasoning outcomes in physical therapy students. Furthermore, this research did not inform how these problem-solving experiences carries over to clinical practice. Future research could include group discussions and/or questionnaires that informs how these educational experiences factor in the clinical reasoning and decision making of physical therapy students during their clinical education experiences.

Implications for practice. The purpose of this research was to explore the effects of case method presentation on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students when working through a musculoskeletal clinical problem. The study results detected moderate-to-large effect sizes for case presentation method explaining a significant amount of the variance of reasoning hypotheses, strategies, and errors between groups. Regarding clinical reasoning hypotheses, the simulated patient experience required participants to make significantly more clinical judgements regarding the clinical data they still wanted or needed to collect (i.e., minimizing reasoning errors), considerations for symptoms the client experienced (i.e., symptom characteristics), and considerations for the client's beliefs regarding their current health condition (i.e., client perspectives). On the other hand, participants in the written case study group exhibited significantly more instances of health condition and personal factors. Regarding clinical reasoning strategies participants in the simulated patient group exhibited significantly more instances of hypothetico-deductive reasoning and reasoning for procedure whereas the written case study group exhibited more pattern recognition strategy. These findings are interesting and mean that simulated patient experiences may be more ideal for facilitating physical examination procedural strategies and clinical judgements geared toward reducing reasoning errors. On the other hand, written case study presentation may be a better choice if the purpose of the educational experience is to assess illness script development and facilitate sound inductive-thinking skills needed for implementing pattern recognition strategies. Additionally, the use of simulated patient experiences has been linked to facilitating non-clinical skills such as conducting subjective interviews (Rivett & Jones, 2008). Similarly, each dyad assigned to the simulated patient group initiated problem-solving sessions by conducting subjective interviews of the actor to obtain early clinical data from which to design their objective physical examination later. These results indicated that environmental differences between groups (e.g., given intentions, and extraneous load) affected the cognitive processing of physical therapy students engaged in clinical reasoning. These results do not promote one type of case-presentation method over another but instead inform physical therapy educators regarding the pedologic decisions they make.

The results of this study have already had significant implications for the physical therapy students I teach. For instance, since the initiation of this project students enrolled in orthopaedic courses in the second year of a three-year professional physical therapy program have had case-method teaching experiences presented via simulated patient. There are a few reasons I selected simulated patient as the case presentation method over written case study. First, one of the core course objectives include these physical therapy students learn how to perform and interpret physical examination findings, especially special tests, safely and appropriately. The use of simulated patients provides students the opportunity to implement more procedural reasoning and hypothetico-deductive reasoning strategies that are more commonly implemented by novice therapists which these students are (Doody & McAteer, 2002; Gilliland, 2014). Second, these courses are offered in the immediate semesters before these physical therapy students participate in their first clinical education experiences. Clinical education experiences are a component of physical therapy professional education whereby working alongside a licensed physical therapist clinical instructor, students facilitate their learning through immersion in physical therapy practice. As mentioned previously, simulated patient experiences have been identified to more closely mirror clinical experiences physical therapy students will encounter in the clinical environment compared to written case study does (Rivett & Jones, 2008). For example, physical therapy students will be required to conduct subjective interviews of their patients when initiating a physical therapy examination during the clinical education experiences like study participants assigned to the simulated patient condition did.

Future practice implications include continued inquiry of the effects varied educational strategies have on facilitating clinical reasoning skills in student physical therapists. Additionally, I endeavor to lead practice changes in physical therapy professional education programs through enhanced involvement in local and national professional organizations (e.g., Florida Physical Therapy Association and American Physical Therapy Association). This will ensure that larger communities of practice also benefit from my experiences as an educator and researcher.

Implications for leadership. A recent call for educational reform in physical therapy has been made in which providing learner-centered education is a central aim for physical therapy professional and post-professional programs (Jensen, Hack, Nordstrom, Gwyer, & Mostrom, 2017; Jensen, Nordstrom, Mostrom, Hack, & Gwyer, 2017). Learner-centered education means focusing education on the learner and what actual and possible learning might occur (Jensen, Mostrom, Hack, Nordstrom, & Gwyer, 2019). This reform effort requires necessary changes to ensure professional education programs are truly providing learner-centered education and the organizational changes needed to provide it effectively. For educational leaders, Robinson (2013) identified three capabilities that should be considered for providing learner-centered education. First, she stated an educational leader must apply relevant knowledge. This research meant to inform the effects of case method presentation on student physical therapist cognitive processing. For instance, it was found that physical therapy students in the simulated patient group exhibit more deductive thinking whereas written case presentation facilitated more inductive thinking processes. Educators can apply this knowledge when making decisions regarding the type of educational experience they want their students to have. For myself, this research process has led to the implementation of “Integrated Clinical Reasoning” experiences for my students enrolled in the orthopaedic physical therapy courses I teach. These experiences require students to act as both therapist and "patient actor" for hypothetical clinical cases created by myself and other experts in orthopaedic physical therapy. The decision for simulated patient experiences over written case study at this time is largely made with the knowledge that physical therapy students at this level of their professional education do not have a well-developed knowledge base for creating illness scripts. Therefore, I desire to provide educational experiences that facilitate sound deductive reasoning skills. Student feedback from these experiences have been mostly positive with minor changes made to make them as impactful as they need to be without overwhelming the students. Fullan (2011) has stated that change efforts succeed when the changes wanted are enacted and tweaked to meet the needs of the organization and its stakeholders. In this instance, I am enacting the change I want to see in my educational practice and thrive to assist others in their endeavors for the educational changes they'd like to make.

Second, is to solve complex problems (Robinson, 2013). One such problem is formulating a good understanding for the environment the leader wants to make a change in and knowing how to navigate it well. According to Buller (2015), institutions of higher education typically embrace a distributed organizational culture. This means that efforts for promoting change in these institutions must include all those affected by the change. This is especially important when implementing changes to policies or practices that were developed by the very individuals the leader is attempting to make changes to. He suggested using change models that provide multiple viewpoints for the need for change and how such change efforts will benefit the organization (i.e., university or college), its faculty, and students. Specifically, Buller has promoted a Ten Analytic Lenses Model for assisting leaders and followers to see the need for and benefits of change initiatives. Personally, I had seen the change I wanted to make through several of these lenses when I implemented the "Clinical Reasoning Integration" days in my orthopaedic courses. For example, the 20/20 lens was clarified when consuming the literature regarding educational practices for facilitating clinical reasoning skills and found that experiences that mirrored real-life situations were both beneficial and perceived positively by students. Additionally, the rearview mirror allowed me to reflect on the educational experiences I've been providing and identified gaps between what I was doing and contemporary best educational practices. I came to the realization that the educational experiences I was providing prior to this journey were mostly teacher-centered (e.g., lecture-based instruction) and not learner-centered as defined by (Jensen et al., 2019). Other views through rose-colored glasses and sunglasses made me consider the benefits and potential draw backs for making this change. For instance, I knew that a lot of class time would be needed to integrate this educational change initiative. A cost-benefits analysis with an understanding of what could be gained and what education would be lost was necessary for making the decision to incorporate more simulated patient experiences in these courses.

The third capability for educational leaders to promote learner-centered education is building trust (Robinson, 2013). Trust exists when there is an understanding between individuals that each wants what's best for the other. For Covey (1989), trust is the "highest form of human motivation" (p. 178) but takes extensive time and effort to build. He has further stated that being proactive, beginning with the end in mind, and putting first things first are about making and keeping promises, the building blocks for trust formation (Covey, 2004). These habits are about the leader establishing self-determined goals, reiterating them, and making the effort to achieve them. To followers, this appears like a leader who clearly communicates goals and then models the way to meet them. This form of leadership is more effective than leaders who simply enforce change on their followers without making any effort to change themselves. Additionally, Covey (2004), has stated that thinking win-win, seeking first to understand, then to be understood, and synergizing are positive habits for developing mutual understanding and valuing differences among team members, the essence of a functional team. These habits require extensive work on the leader's part to develop a full appreciation of their followers drive for success, creativity, and personal goals (Bass & Avolio, 1994). Through trust, positive learning environments emerge that are beneficial to both student and educator. In such environments both physical therapy students and educators become learners (Weimer, 2013). That is, students learn the knowledge and skills necessary to succeed in their clinical practice while educators learn best practice standards and how to adapt them as necessary to meet the individual needs of their students.

Regarding my future practice as an educational leader, I will continue to consider Robinson's (2013) three capabilities for providing learner-centered education. These capabilities require a commitment to lifelong learning, systems thinking for solving complex problems, and exhibiting those habits that foster trust building. I believe this process has made me a better educator and researcher and will be beneficial to my work as an educational leader from this time onward.

Limitations

This study was subjected to several limiting factors that research methods using verbal reports as data often have. First, verbatim transcriptions are often regarded as low inference data in general meaning they are not the ideal data set for obtaining a complete understanding for the concept under investigation (Gilliland, 2017). Second, due to the need for creating verbatim transcriptions, verifying their accuracy and the coding process in general, only small sample sizes are feasible for analysis. This lends to findings that are mostly non-generalizable and prone to larger Type II errors (Marshall & Rossman, 2016; Vogt, 2007). Additionally, this study investigated the effect of case presentation on physical therapy students working in pairs. This decision was made to enrich the data set by providing a higher frequency of verbalizations than physical therapy students produce when working alone (Ladyshewsky, 2004). However, clinical practice typically requires the clinician to work in isolation with their clients when conducting physical examinations. Therefore, the study results cannot be directly compared to the reasoning process as it's applied in clinical settings. Furthermore, it's possible that an artifact of having two participants engaged in clinical reasoning simultaneously was present. For instance, another explanation for exhibiting a higher number of minimizing reasoning error hypotheses and reasoning for procedure strategy from participants in the simulated patient group could've been due to each participant wanting their teammate's consent before conducting further physical examination tests and measures. This could've skewed these results to finding a significant difference in these reasoning hypothesis and strategy categories when none existed.

Conclusion

This study investigated the effect of case method presentation on the clinical reasoning hypotheses generated, strategies implemented, and errors made by physical therapy students working through a musculoskeletal clinical problem. Significant differences were seen for several clinical reasoning hypotheses, strategies, and errors between groups. Multiple conceptual frameworks assisted in explaining the study findings. Remarks regarding generalization of the study findings cannot be made at this time due to the small sample size and significant differences between how the problem-solving sessions were conducted in this study and actual client experiences in a more traditional clinical setting.

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