Exploration of Students’ Clinical Reasoning Development in Professional Physical Therapy Education
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Background and Purpose. Given the complexity of the current health care environment, effective clinical reasoning skills are fundamental to making critical patient care decisions. The purpose of this study was to explore the clinical reasoning abilities of students across time in 1 professional Doctor of Physical Therapy (DPT) curriculum.

Methods. Qualitative methods were used to describe the longitudinal development of students’ clinical reasoning skills.

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Ninety-eight students from 2 consecutive class cohorts participated. Low inference data from the Clinical Reasoning Reflection Questionnaire (CRRQ) and narrative comments from the Clinical Performance Instrument (CPI) were analyzed using the constant comparative method. Open coding was used to initially categorize the data followed by axial coding to identify resulting themes.

Results. Three categories (beginning, intermediate, and entry-level) and 8 themes emerged from the data describing student development of clinical reasoning skills. The following themes surfaced under the beginning clinical reasoning process category: focus on self, compartmentalized thinking, and limited acceptance of responsibility. Themes in the intermediate category were: procedural performance, initial stages of recognition and using context, and improved reflection on performance. Themes in the final entry-level category were: dynamic patient interaction and integrating situational awareness.

Discussion and Conclusion. The results of this study demonstrate a progression in the development of these students’ clinical reasoning process around the dimensions of self, context, and responsibility across the curriculum. Outcomes reveal these key aspects of the clinical reasoning process: (1) it is a gradual developmental process across time; (2) the Dreyfus model of skill acquisition may apply to the development of clinical reasoning skills in physical therapy students; and (3) increasing intensity and depth of the reflective process may be a critical component in the advancement of the clinical reasoning process. Further research is needed to determine the best strategies to assess clinical reasoning abilities in physical therapy students and to discern approaches to enhance this learning process.

Key Words: Clinical reasoning, Student learning, Professional education.

INTRODUCTION

In the current dynamic health care environment, patients often present with numerous comorbidities within a multifaceted social and economic context, while insurers continue to limit payment for necessary services. In order to meet clinical practice demands, educators are responsible for clearly understanding the development of clinical reasoning abilities and facilitating student development of strong clinical reasoning skills.

Clinical Reasoning

Understanding the clinical reasoning process is challenging, given the complexity of factors that contribute to the reasoning process and the variety of definitions that exist in the health professions literature. For example, clinical decision making, critical thinking, and clinical reasoning have been used interchangeably to describe the same phenomenon. For the purposes of this paper, the authors chose to operationally define these terms. In the broadest and most general sense, clinical reasoning can be summarized as the thinking and decision making of a health care provider in clinical practice. Essentially, clinical reasoning is the critical thought process and judgment behind one’s action, whereas clinical decision making is the action that is taken on this process. To better understand this difference, it may be helpful to think that one can make a decision without any reasoning or thought process behind that choice. Nikipoulo-Smyrni and Nikopoulos define clinical reasoning as a reflective process that engages the patient and family in collaborative decision making, taking into account the critical contextual factors to determine an
appropriate clinical intervention. Using this definition, one can see both contextual and cognitive aspects of clinical reasoning. Consistent with other definitions, critical thinking would be a component of the cognitive aspect of clinical reasoning. Critical thinking as a cognitive skill involves inductive and deductive thinking, evaluation, and analyses, but does not encompass judgment, reflection, or the many contextual factors that are a part of clinical reasoning. Clinical reasoning is complex because it involves the application of cognitive, affective, and psychomotor skills while using a reflective thought process to make decisions and judgments based on a patient presentation.

Emphasis on clinical reasoning in education has been reported in medicine, dentistry, occupational therapy, physical therapy, and nursing. In fact, the American Association of Colleges of Nursing (AACN) has stressed the importance of developing and assessing clinical reasoning skills in nursing students as part of nursing education. A recent call for radical transformation in nursing education includes an emphasis on clinical reasoning and multiple ways of thinking, which will enable nurses to practice safely, compassionately, and accurately in different practice settings. Similarly, the American Physical Therapy Association (APTA) also identifies clinical reasoning as a skill and practice expectation described in the Normative Model of Physical Therapist Education, yet a comprehensive approach for facilitating and assessing clinical reasoning across physical therapy education programs has not been clearly established.

The advancement of any skill is developmental in nature and requires practice over time. Dreyfus and Dreyfus proposed a framework of skill acquisition that may be applicable to the development of clinical reasoning abilities in physical therapy students. This model has been applied in medicine and nursing to describe various benchmarks (novice to expert) along the continuum of clinical skill development, as well as key characteristics/traits associated with each level. The Dreyfus model originally described the developmental model of skill acquisition when observing the progress of pilots and chess players over time. In the model, the learner passes through 3 phases when moving from novice to expert. During the first phase, the learner shifts from using absolute rules to incorporation of past experiences to guide decision making. The learner then moves away from gathering unrelated bits of information to cohesively “seeing the big picture” in the second phase. Finally, the learner becomes an integral part of the situation and no longer views himself/herself as an isolated component outside of the experience. The evidence in the physical therapy literature about clinical expertise suggests experts rely on past experiences, pattern recognition, and synthesis of important patient information to make decisions. Specifically, Jensen and colleagues suggest that a clinician’s application of knowledge and skill, paired together with the intuitive ability to vary an examination or treatment based on reflective problem-solving and patient interaction, distinguishes a novice from expert clinician. Based on the above information, the Dreyfus model could be a guiding framework for data analysis in looking at benchmarks for skill acquisition as they apply to clinical reasoning.

Assessment of Clinical Reasoning

A limited number of methods and tools exist in the literature to assess the clinical reasoning abilities of students in the health professions. Some of these instruments include the script concordance test (SCT), concept mapping constructs, think aloud techniques, quantitative standardized tests, and qualitative measures of written reflection, interview, or focus group responses. The SCT is frequently cited in the medical education literature as a tool to assess clinical reasoning abilities of medical students and residents in ambiguous and uncertain situations. This test compares the test taker’s ability to make decisions and interpretations using multiple sources of data while cross-referencing these interpretations to an expert panel. The SCT was used in physical therapy to assess knowledge and reasoning ability around seating and mobility prescription. The authors found that although the test was able to differentiate experts from novices in this area, it was challenging to determine the appropriate measures or characteristics of a seating and mobility expert upon which to base the test. Concept maps are another tool to measure and facilitate clinical reasoning abilities of students in the health professions, particularly in dentistry and nursing. The purpose of a concept map is designed to help students link concepts together in an effort to “visualize” the thought process and content knowledge. In addition to concept maps, think aloud techniques can also help the educator to see the students’ reasoning process.

Standardized instruments for measuring general critical thinking skills have been applied to predict reasoning capacity in physical therapy students. However, these tests are only able to assess a single component of the clinical reasoning process and therefore may not accurately reflect true clinical reasoning ability. The Health Sciences Reasoning Test (HSRT), specifically designed to assess critical thinking skills for health profession students, was found to be more valid in eliminating the ceiling effects found with other tools, including the California Critical Thinking Skills Test (CCTST). Nevertheless, the authors of this study found this single test to be inadequate in assessing clinical reasoning skills, as it primarily measures only 1 component of clinical reasoning (critical thinking) and doesn’t address other contextual variables. Studies performed in nursing education suggest that the complexity of clinical reasoning is too narrowly defined by such quantitative assessment tools. These instruments attempt to objectify critical thinking, but to truly explore the process of developing clinical reasoning skills, qualitative methods incorporating reflection are needed.

While the dissemination of research findings evaluating clinical reasoning skills in the health professions has primarily occurred in nursing and medical literature, little has been studied in physical therapy to assess this skill development over time. In this investigation, faculty wanted to ascertain the development of current clinical reasoning abilities of students as they moved through the program. Once this was determined, faculty members were interested in using this evidence of student learning to inform their teaching strategies. The purpose of this study was to explore the development of student clinical reasoning abilities over time in 1 professional Doctor of Physical Therapy (DPT) program.

METHODS

Project design

Qualitative methods were utilized to explore the longitudinal development of student clinical reasoning capabilities across the curriculum at 1 professional DPT program in the Midwest. Specifically, written student responses to a Clinical Reasoning Reflection Questionnaire (CRRQ) were used as the primary data source, coupled with narrative responses from the Clinical Performance Instrument (CPI) as a secondary data source and triangulation of the core themes.

Curriculum Infrastructure

Description of the systems-based, integrated lifespan curriculum model is needed to understand the timing of data collection (Figure 1). Beginning with the foundational sciences and essential clinical skills coursework, the curriculum progresses to include clinical, integrative, and contextual sciences. Clinical experiences are interspersed between semesters, culminating in full-time exposure at the end of the curriculum. Case application to facilitate clinical reasoning skills is threaded throughout the curriculum, beginning with basic cases early in the curriculum and pro-
progressing in context and complexity over time. To confirm student safety and competence in patient management, the Clinical Competence Performance Examination (CCPE), a practice-based case simulation in which faculty serve dual roles as patient and evaluator, was administered at the end of each academic semester prior to participating in a clinical experience.

Participants

Students in good academic standing enrolled in the professional DPT program at Creighton University in Omaha, Nebraska, were eligible for inclusion in the study. All students were recruited via email invitation at varying points in the curriculum, which spans 8 semesters across 3 calendar years (Table 1). A total of 98 students from 2 consecutive class cohorts participated in this study. Forty-nine students were recruited in semester 6, and 10 in semester 8 from Class B. For Class A, 49 students participated in semester 4, 48 in semester 6, and 8 in semester 8 (Table 2). During the initial phase of data analysis, the need to capture participant insight at an earlier point in time emerged. Therefore, the investigators collected data from Class A in semester 4 but were unable to do so for Class B, as these students had already progressed in the curriculum. In semester 8, a purposive sampling method was used to recruit student participants, on account of the curriculum not requiring a CCPE component at that point in time. Sixteen participants representing a range of academic and clinical abilities (low to high GPA, successful to exemplary scores on CCPE and CPI) were embodied in the sample. The specific process and timeline for collection of student participant data is further described in the procedure section.

Data Collection Instruments

The purpose of this study was to explore the clinical reasoning skills of professional physical therapy students across the curriculum. However, few qualitative valid and reliable mechanisms exist to assess this skill set in physical therapy. Therefore, the CRRQ was developed to identify and assess these abilities. In addition, the CPI was used to collect data during the experiential phase of the curriculum.

Clinical Reasoning Reflection Questionnaire (CRRQ). The CRRQ (Appendix A) is a 6-question, online survey developed by the current investigators to facilitate depth of reflective response. Its construction was based on key theoretical constructs in clinical reasoning research41-44 and expertise in survey design. A major challenge in assessment of learning is finding ways to uncover and understand the diversity of reflective processes used by students. Using dimensions of the International Classification of Functioning, Disabil-

Table 1. Timeline of Data Collection Across Curriculum

<table>
<thead>
<tr>
<th></th>
<th>Semester 4</th>
<th>Semester 6</th>
<th>Semester 7</th>
<th>Semester 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Reasoning Reflection Questionnaire</td>
<td>Class A (n = 49)</td>
<td>Class A (n = 48) Class B (n = 49)</td>
<td>Class A (n = 48) Class B (n = 49)</td>
<td>Class A (n = 48) Class B (n = 49)</td>
</tr>
<tr>
<td>Clinical Performance Instrument</td>
<td>Class A (n = 49) End of a 3-week clinical experience</td>
<td>Class A (n = 48) Class B (n = 49) Week 10 of a 20-week clinical experience</td>
<td>Class A (n = 48) Class B (n = 49) End of a 16-week clinical experience</td>
<td></td>
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</tbody>
</table>

Table 2. Participant Demographics

<table>
<thead>
<tr>
<th>Participants</th>
<th>Average Age</th>
<th>Baccalaureate Degree Prior to Admission</th>
<th>Gender</th>
<th>Ethnic Background</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>23</td>
<td>79%</td>
<td>Male = 33% Female = 67%</td>
<td>Asian = 4% Black = 4% Caucasian = 92%</td>
<td>(n = 49) semester 4 (n = 48) semester 6 (n = 6) semester 8</td>
</tr>
<tr>
<td>Class B</td>
<td>23</td>
<td>77%</td>
<td>Male = 27% Female = 73%</td>
<td>Asian = 2% Black = 2% Caucasian = 96%</td>
<td>(n = 49) semester 6 (n = 10) semester 8</td>
</tr>
</tbody>
</table>
ity and Health (ICF) framework to broaden student perspective of patient management, questions were crafted around core concepts including (1) metacognitive thinking, (2) struggling with uncertainty, and (3) critical self-reflection and growth. Students’ metacognitive skill was addressed by asking the participant the following: “Describe your thought process and initial impressions about the selected case you’ve been given for the clinical competence performance examination. What do you think the patient’s priorities from the physical therapist’s perspective could be that you would want to address?” (CRRQ presurvey question #2). The student provides evidence of his or her metacognitive process (disclosing the thinking process by “getting the inside out”) just as elementary students might outline steps in solution of a math problem. The second core construct centered on the concept described in medical education as “struggling with uncertainty.” Experiential learning theories suggest that struggling in a dynamic environment and being challenged to reach beyond one’s comfort zone with guided reflection can facilitate student learning.

This core construct was illustrated by the following question: “Based upon your interaction with the patient during the physical therapy examination and intervention piece of the Clinical Competence Performance Examination, how did you modify your plan of care or approach to this patient?” (CRRQ postsurvey question #2). In this case, the question encourages the student to discuss the difficulty in thinking in a new and challenging environment versus the traditional approach of asking for the right answer. Another core concept embedded into this questionnaire was critical self-reflection and growth, a concept described in the following question: “If you were able to repeat this Clinical Competence Performance Examination experience, what would you do differently and why?” (CRRQ postsurvey question #1). This question facilitates reflection and allows the student to demonstrate any personal or professional growth that may have occurred as a result of this interaction. The remaining questions were developed to determine the students’ abilities to apply the ICF framework to the patient and to describe their clinical reasoning process.

Initially, the CRRQ was pilot tested with a core group of faculty (n = 5) and students (n = 5) and then revised based on feedback. One question was modified to explicitly label the components of the physical therapy examination, ask the participants to provide specific examples, and justify rationale to better reveal the participant’s thought process (CRRQ presurvey question #3). Another question was changed to specifically label and define personal factors for the participant to avoid confusion and to ask “how” the participant modified the plan of care to capture part of the reasoning process (CRRQ postsurvey question #2). Three female physical therapy faculty members and 2 males with expertise in survey development piloted the survey during the CCPE to determine student feasibility and ability to gather thought processes during this examination. Three female and 2 male physical therapy students in their third (out of 4) year in the program also completed the questionnaire and provided feedback for areas of clarity and readability.

Clinical Performance Instrument. The CPI is the most commonly used tool by students and clinical instructors (CI) to evaluate student performance during a clinical experience. Narrative comments chosen from CPI item #7 (labeled “Clinical Reasoning”) were used in this study as an additional data point to provide the CI’s external perspective during participant clinical experiences (Appendix B).

Procedure
There were 2 class cohorts that participated in this study (Table 1). All members of Class B were allowed 20 minutes to complete the computerized CRRQ immediately prior to interacting with a simulated patient as part of the CCPE. Immediately following the simulation experience, participants were allotted an additional 20 minutes to complete the CRRQ reflection questions. This process occurred at the end of semesters 6 and 8 of the curriculum. Investigators then reviewed CPI data from the midterm (week 10) of the 20-week clinical experience that followed (semester 7). At the end of semester 8, 10 participants from Class B again completed the CRRQ before and after completion of a simulated patient examination (similar to the CCPE). CPI data were reviewed upon completion of the final clinical experience (semester 8). One year later, all members of Class A completed the CRRQ using the same data collection process beginning at the end of semesters 4, 6, and 8. CPI data were then reviewed at the end of the 3-week clinical rotation that immediately followed the end of semester 4. CPI data for Class A were again reviewed at the midterm (week 10) of the 20-week clinical experience that followed (semester 7). Additionally, 6 participants from Class A completed the CRRQ process at the end of semester 8, and their corresponding CPI data were reviewed. Throughout this process, the CPI data from either midterm or final that were most closely aligned in time frame to the CRRQ were used as a data point. Table 1 outlines the timeline of data collection across the curriculum.

Data Analysis
All narrative responses from students (CRRQ) and CIs (item #7 on CPI) were gathered via computer transcripts for analysis and triangulation of data sources. The low inference data from the CRRQ and CPI were analyzed using the constant comparative method. During the open coding phase, 5 investigators who were involved with all aspects of project conceptualization and data collection reviewed all transcripts and generated initial codes independently. Open coding consisted of identifying common key words, concepts, and word phrases from the data sources. The preliminary codes were then analyzed until saturation was reached and concepts were sufficiently categorized. Axial coding was performed by the 5 investigators during 6 meetings in which the authors collectively identified the core themes: focus on self, compartmentalized thinking, limited acceptance of responsibility, procedural performance, initial stages of recognition using context, improved reflection on performance, dynamic patient interaction, and integrating situational awareness. These themes emerged during analysis and consensus building across the initial coded categories, while atypical cases that failed to fit into established categories continued to be discussed until agreement was reached. A final step generated a data matrix to identify relationships among the categories.

Trustworthiness of the Study
In addition to the use of low inference data and triangulation of student and CI data, several standards of verification were used to enhance the study’s methodological rigor. The research team consisted of professionals from didactic and clinical education, academic administration, and clinical specialties in cardiovascular and pulmonary, orthopedic, and pediatric physical therapy. All 5 investigators participated in the entire research project from conceptual design to data collection and analysis, allowing triangulation of investigator coding during data analysis.Bracketing efforts identified the investigators’ preconceived assumptions about the topic area so that potential bias could be recognized. To accomplish this, the authors attempted to improve their reflexivity by discussing perceptions that might influence coding and data conceptualization. Among the investigators, the concepts that could potentially bias the data interpretation included level of responsibility, comparison of professional students to residents, paternalistic perspective, bias as professional educators, and unrealistic graduate-level expectations. Finally, a sixth investigator who had no involvement in ini-
Table 3. Data Matrix: Relationships of Themes

<table>
<thead>
<tr>
<th>Beginning</th>
<th>Curricular Timing</th>
<th>Entry-Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Focus</td>
<td>Emerging contextual</td>
<td>Dynamic Patient Interaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recognizes and applies contextual information</td>
</tr>
<tr>
<td>Internal</td>
<td>Intermediate</td>
<td>Demonstrates flexibility in patient examination</td>
</tr>
<tr>
<td>Rigidity</td>
<td></td>
<td>Listens and observes more actively</td>
</tr>
<tr>
<td>Egocentric responsibility</td>
<td></td>
<td>Reflects on performance during patient interaction</td>
</tr>
</tbody>
</table>

**Focus on Self**
- Evaluates own performance
- Shows little awareness of patient issues

**Compartamentalized Thinking**
- Driven by routine and rigid thought process
- Performs components of examination as isolated “boxes” of familiar information
- Unable to integrate information

**Limited Acceptance of Responsibility**
- Blames outside factors for own mistakes
- Fails to identify weaknesses

**Initial Stages of Recognizing and Using Case Context**
- Begins to consider contextual factors (age, environment, situation)
- Demonstrates difficulty adjusting to unexpected findings

**Procedural Performance**
- Focus on physical therapy examination (tests and measures) component of patient management
- Completes scripted examination
- Unable to see the “big picture” and incorporate components of the International Classification of Functioning, Disability, and Health (ICF)

**Improved Reflection on Performance**
- Evaluates own performance more meaningfully
- Recognizes mistakes and plans for future changes

**Curricular Timing**
- Intermediate

**Emerging Evidence of Situational Awareness**
- Recognizes and applies contextual information
- Identifies and considers individual patient factors

**Entry-Level**
- Dynamic Patient Interaction

**Results**

Participants
Data indicated that participants progressed in their clinical reasoning process across the curriculum, beginning with a strong focus on self and procedural skills then transitioning toward a focus on the needs of the patient and an emerging situational awareness by the end of the curriculum. Analysis specifically revealed a shift in focus (internal to external), emerging contextual awareness, and reasoning ability (rigid to flexible), which resulted in progression from beginning, through intermediate, to professional stages of the clinical reasoning process (Table 3).

**Beginning Clinical Reasoning Process**
Three themes emerged from the CRRQ data early in the curriculum during semester 4 (n = 49): (1) focus on self, (2) compartmentalized thinking, and (3) limited acceptance of responsibility.

**Focus on self.** CRRQ reflections centered on what the student might have done to improve performance without recognizing patient-centered issues. For example, when asked, what would you do differently in the future if you could repeat this experience again, 1 respondent stated:

*I think that I prepared very well for this practical which is why I was confident in my skills and performed well. The 1 area that I need to improve on is my efficiency. I had the patient repeat positions because I forgot to complete certain tests and measures.*

Another replied:
*I would have practiced more with specific interventions and my reasoning for those interventions. I had good ideas of what I wanted to do, but I could not back up everything with a purpose, even though one may have existed.*

These responses indicate participants are in the early phases of learning a skill, as they are focused on their individual performance versus the impact on the patient.

**Compartamentalized thinking.** This theme revealed participants’ rigidity in thought process and inability to integrate information. Participants seemed to complete tests and measures as a matter of routine without responding to anything the patient was demonstrating or saying. When asked what might be done differently next time, 1 respondent stated:

*I was too busy going through the check-
list in my head, and I wasn’t listening to the patient. I felt like I could have come to the diagnosis a lot sooner if I was listening instead of worrying about what my next test would be.

A different respondent explained:
I wouldn’t have stopped myself when I did. I pigeonholed the neuromuscular system as the testing of nerves only and did not assess function, so I never got the patient out of the chair... I was stuck in my mental box.

In these cases, the participants describe a rigid thought process in their approach to patient management when categorizing patients into “boxes.”

The data from the CI’s viewpoint, as gathered from item #7 on the CPI, indicated that students at this level had difficulty organizing data from patients and understanding how to interpret patient data. For example, I CI commented, “He has trouble determining when to perform neurologic diagnostic testing and the meaning of this information.”

This statement supports the theme of compartmentalization thinking, as students had difficulty integrating data as they arbitrarily bound the results of tests and measures and were unable to access that information to help the patient.

Limited acceptance of responsibility. Thirdly, external attribution of blame for student mistakes was evident. When asked what might be done differently if the experience could be repeated, a respondent indicated:

I think the main thing I would do differently is bring in children to be the patients for the pediatric cases. I think that it is very subjective to assume whether or not the student is able to work well in pediatrics by basing that judgment on their interactions with an adult acting like a child.

A different respondent indicated:
The only other thing I would change is maybe the instructors’ assistance before the exam. Some instructors, when presented with questions about the material, were so vague that it did not answer the questions at all. I understand that their goal is to not give away too much information, but I feel that if a student has studied enough that they are asking a well-educated question, the instructor should respond to that question with a thorough, complete answer.

Another stated:
I would be more prepared in studying other diagnoses, in addition to what was in the lab handouts. I had briefly studied the musculoskeletal notes but was not expecting subacromial bursitis since we did not cover it in lab.

In these examples, the participants did not identify their own areas of weakness in performance. Rather, they provided external attribution for deficits.

Outlier Cases

While many participants in the beginning clinical reasoning group struggled to focus beyond their own psychomotor performance, a few students did demonstrate greater depth of reflection, indicating that they would focus more on the patient’s needs. For example, 1 student stated:
I would change my exam so that I played with the child first, which would (1) build a relationship of trust between us, and (2) allow me to observe as she played, which would allow me to focus in on what it is that I would need to look at for my examination. I need to be more imaginative with my interventions, especially for children, so that they are functional as well as fun for the child.

This respondent is beginning to identify play and fun as important factors to the child, indicating an emerging shift away from self and toward the child’s needs.

A comment from the CPI data supports the notion that a few students were able to emphasize the patient’s needs rather than their own. For example, I CI stated, she “demonstrates an understanding of the need to establish goals with patient/family input.”

Another participant took full accountability for his/her performance during the examination, contrary to the theme of blaming others, as evidenced by the following response:
Well, I failed the neuro part of the exam, but I deserved to fail it. I was not fluid with my overall examination and the flow of my testing was choppy. I forgot several important factors of the exam, including testing blood pressure, range of motion, and bed mobility. When I did remember them, it was during a point that made it awkward for testing. Overall, I am glad that I have to take it again because I do need to perform better, and it will help me learn.

While the frequency of these responses was not great enough to categorize as a theme, they are worth mentioning since they offer a different perspective.

Intermediate Clinical Reasoning Process

As described earlier, data early in the clinical reasoning process revealed that participants were focused on their own individual performance and unable to incorporate patient information into the process. However, as progression through the curriculum occurred, participants began to incorporate patient information into the clinical reasoning process and planning. Three themes emerged from the data collected in semester 6 (n = 97) in the curriculum. These themes included: (1) a focus on procedural performance by students, (2) an ability to use the initial stages of recognizing and using context when evaluating a patient, and (3) evidence of improved reflection on his or her performance.

Procedural performance. Procedural performance was an emerging theme that indicated participants were focused on specific procedural aspects of patient management without recognizing the importance of context and all components of the ICF model. When asked to describe an initial thought process and anticipate patient priorities based on case information, a participant responded, “My primary area of focus for this patient will be to address his knee pain and look for a physical cause.” Participants were also asked after the experience to describe what they would do differently if they were able to repeat this interaction again. One explained, “I would make sure to do all the screening techniques, especially for the hip because I forgot that.” At this point, participants exhibited the ability to identify basic or foundational components of the patient management process related to performing tests and measures, but were unable to see the larger patient picture that would encompass all of the components of the ICF model, including the impact on a patient’s ability to participate in activities of daily living (ADLs) and contribute to society.

The data from the CPI revealed that students had difficulty incorporating patient factors, other than textbook information, into their reasoning process. For example, 1 CI commented, the student is challenged to “develop a plan of care specific to the person rather than an injury.”

Initial stages of recognizing and using case context. During semester 6, participants were beginning to identify the need to incorporate contextual factors such as age, environment, and situation into the patient management process with “basic, straight-forward cases.” In addition, they could envision a predetermined “picture” of the patient based on initial case information, but had difficulty adapting to information that was different from their expectations. When participants were asked how personal factors, including patient beliefs, perspectives, culture, attitude, socioeconomic status, and education would impact the planned physical therapy examination and
intervention, 1 respondent reported, “I think I need to take into consideration that Brian is not an adult, and perhaps will not be able to give a complete subjective history as well as I would like.” This response demonstrates recognition that age and some situational factors will be important considerations in the patient examination. When asked to describe what they would do differently next time, a participant responded:

I would be more organized with my objective exam. I went in expecting one thing and then almost immediately during the exam it presented as something else and I didn’t know what to do.

This response highlights the challenge the participants had in adapting to different patient presentations.

The CPI data from the CIs’ perspectives support the theme of the initial stages of case context. These data suggest the students demonstrate some proficiency in utilizing a sound clinical reasoning process with “straightforward cases,” but had more difficulty with “complex conditions.” One CI stated: “She needs assistance 20% of the time to synthesize data from multiple sources into 1 picture and treatment plan.” Another responded, “He continues to require some cueing to problem solve complex situations.” A different instructor explained, “He was able to consistently perform good clinical decision making with straightforward diagnoses, but needs help with more complex patients.”

Improved reflection on performance. The final theme to emerge during the intermediate reasoning process suggested participants demonstrated an improved reflective capability after their interaction with the patient. When asked what could be done differently in the future, a participant responded, “I would do more to make the patient comfortable and trusting of me.” Another stated:

I would organize my examination according to the patient instead of having a specific plan. I planned for the patient to be positioned in supine and when he came in his wheelchair, I didn’t have a plan anymore. I would have been more flexible according to the patient.

In addition, 1 participant indicated, “I would be more hands-on with the patient to let them know I am there for them.” These responses demonstrate “reflection-on-action,”56 where participants were able to reflect on the experience after the interaction, helping them determine changes they would make in the future when interacting with similar patients.

Data from the CIs indicate students at this level were able to reflect on the situation and make appropriate changes to patient care plans. One CI stated, “she recognized her current experience limits and would seek help when needed,” demonstrating the student’s ability to think about her skillset, identify the need for additional help, and take appropriate action.

Outlier Cases

Once again, a small minority of students in the intermediate clinical reasoning stage recognized that they should treat the whole patient and must adapt the physical therapy examination and intervention to meet the patient’s needs. For example, 1 participant commented, “I would focus on the large picture instead of each individual piece.” Another reported that he would “listen to the patient to understand his or her perspectives and be aware and sensitive to them. You have to meet the patient where they are. If the patient has certain beliefs, you have to respect those.” These participants are articulating a focus away from their own individual performance as a student therapist and directing their attention to the patient’s needs. This was not a common response in semester 6 data.

Entry-Level Clinical Reasoning Process

The following 2 themes emerged from the data collected in semester 8, just prior to graduation: dynamic patient interaction and evidence of integrating situational awareness. In the beginning and intermediate clinical reasoning process groups, participants were moving from a focus on self to incorporating information from the patient into their clinical reasoning. Participants in the entry-level group routinely integrated patient data into their clinical reasoning process and began to apply this information in different situations.

Dynamic patient interaction. Dynamic patient interaction was a theme implying that participants were flexible and able to change direction during the patient examination based on verbal or nonverbal responses from the patient. This included active listening and an ability to ask the patient appropriate questions, as well as the ability to anticipate the unknown. In addition, participant use of reflection-in-action, or changing one’s behavior in response to patient cues during the encounter, is an important component of this theme.54,56 For example, when asked, “How did you modify your plan of care or approach to this patient?” a participant answered, “Half way through the exam, the patient mentioned something about having dizziness. I dove further into this, differentiating between dizziness, light-headedness, and spinning sensation.” Another responded:

Based on the patient case, it seemed like

The most influential component at this point will be what the patient brings to the table, what is most important to them, what do they perceive as chief complaints, their beliefs about needing to improve.

These replies indicate that the participants are able to not only engage in active listening, but also alter their own actions in determining tests, measures, and interventions.

Data from the CPI suggest students were able to change the plan of care based on the patient’s response. One CI reported, “The student recognizes when the plan of care is too simple or too challenging and quickly adapts to meet the needs of the patient within that session.” Here, the CI is identifying the student’s ability to demonstrate reflection-in-action56 as a higher level of reflection.

Integrating situational awareness. This theme represents participant ability to recognize and apply contextual information to the patient management process and relate to the “patient’s story,” demonstrating narrative thinking. When asked about modifying the plan of care or approach to the patient, 1 respondent answered:

Since my patient has a fear of falling, I asked her about that issue. She pointed out her cat got in her way and getting out of the shower was difficult. I asked about any rugs and lighting. I provided education on limiting rugs and uneven surfaces, and good lighting to reduce the risk of falls. I also assured her that she had pretty good balance at this point, and provided education on activities that can be incorporated at home to improve her current balance abilities.

Another responded:

I would have asked the patient more questions about his ability to perform ADLs such as cooking, laundry, dressing, bathing, and about the family support that he identified as important to his independence. This information would
Outlier Cases

In contrast to the predominant common themes, some respondents did emphasize their own performance limitations without moving toward a patient focus. For example, when asked how the patient management process was modified based on the interaction with the patient, a respondent stated:

*I will review special tests and differential diagnosis information prior to performing an exam. This might make the objective portion flow better and I would feel more confident with the exam techniques after having just reviewed them.*

This response was similar to data from the beginner level of the clinical reasoning process with an emphasized focus on the needs of the participant versus the patient.

DISCUSSION

The development of students’ effective clinical reasoning abilities is a critical objective of physical therapy professional curricula. Unfortunately, the complicated and cognitive nature of the clinical reasoning process presents challenges to both teaching and assessment of this skill. The aim of this study was to explore the longitudinal development of students’ clinical reasoning abilities across the curriculum to better understand this reasoning process and ultimately inform teaching and learning. A qualitative approach was used to explore student learning and provide faculty with insights into the development of student reasoning abilities at various points in time. For these students, we found that clinical reasoning development occurs as a gradual progression across time, and that the Dreyfus model of skill acquisition may be a useful framework in categorizing clinical reasoning development. In addition, student reflections, as seen in the themes, demonstrated a developmental progression in gaining insight and depth across time. This reflection may contribute to the advancement of the clinical reasoning process.

Figure 2 conceptualizes the developmental progress of clinical reasoning skills of a typical student over time. This figure highlights the gradual nature of this process through step-by-step progression from early performance to professional performance. These steps are supported by the themes identified at each assessment point. Throughout the progression of the curriculum, students tended to move from scripted, procedural, self-focused performance to a more fluid, dynamic, patient-focused performance. Henrick et al found a similar progression over time and a transition from simple and internally focused to complex and externally focused concepts around clinical reasoning in undergraduate physical therapy students in New Zealand. This focus on self and procedural performance is consistent with other evidence from novice learners. Not surprisingly, Babyar and colleagues found that physical therapy students self-rated themselves as more confident in their clinical reasoning skills as they progressed in the education program. In addition, studies done investigating the nov-

Figure 2. Conceptual Framework
ice to expert continuum in physical therapy practice reinforces a developmental progression across time, beginning with a decreased awareness of patient factors and progressing to an increased awareness of context and patient factors.\textsuperscript{18,60-63} The work of Jensen et al revealed expert practitioners utilized a collaborative clinical reasoning process and facilitated patient empowerment to increase self-efficacy more frequently and effectively than their novice counterparts.\textsuperscript{60}

Another key finding is the potential application of the Dreyfus model of skill acquisition to the progression of clinical reasoning skills in physical therapy students. This model has been applied in medicine and nursing to describe various benchmarks (novice–master) along the continuum of clinical skill development, as well as key characteristics/traits associated with each level.\textsuperscript{16,17} We found that the compartmentalized thinking of an early learner is similar to what Carraccio and colleagues in medicine describe as a novice learner who uses rules to govern his thinking, must link cause with effect, and is challenged to integrate and synthesize information.\textsuperscript{16} This inability to see the “big picture” and put the “pieces of the puzzle” together is illustrated by the respondent who stated, “I pigeonholed the neuromuscular system as the testing of nerves only and did not assess function.” Later on in the program, students were able to demonstrate their ability to understand more about the contextual factors that are important in patient care and were more aware of the situation (situational awareness) as a component of their thought process. The theme of integrating situational awareness, in which participants demonstrated emerging signs of recognizing patterns of clinical presentations through context and the ability to see the “big picture,” highlights concepts of the “competent” level, as described by Carraccio and colleagues.\textsuperscript{16}

The third key point (Figure 1 and Table 3) is the ability of the students to reflect and the various levels of reflection (reflection-on-action and reflection-in-action)\textsuperscript{56} that may contribute to the advancement of clinical reasoning skills. Wainwright and colleagues describe the usefulness of reflection in differentiating the thinking processes of novice versus expert physical therapy clinicians and how reflection helped identify the complexity of this process.\textsuperscript{64} The available evidence supports the finding that reflection is an essential component of professional development and the development of clinical reasoning.\textsuperscript{19,65-67} Data indicated participants progressed along a continuum over time in their clinical reasoning skills. This progression toward professional practice may have been facilitated by participant ability to engage in meaningful reflection and accept responsibility for their own performance, as seen in the “improved reflection on performance” and components of “dynamic patient interaction” themes.\textsuperscript{58}

Upon reflection, a respondent stated, “I would do more to make the patient comfortable and trusting of me.” In addition to reflection, the frequency and timing of self-reflection distinguished experienced from novice therapists.\textsuperscript{64} Wainwright et al found that expert practitioners utilized reflection-in-action,\textsuperscript{56} indicating they were able to change their thought process and action during the patient/therapist encounter, while novice practitioners relied on self-reflection that occurred following the patient-therapist interaction.\textsuperscript{64} This is consistent with the results of this study, indicating participants in the middle of the curriculum were just beginning to use reflection-on-action\textsuperscript{56} while progressing to reflection-in-action\textsuperscript{56} toward the end.

Although the majority of participants progressed along the clinical reasoning developmental continuum, some students did not progress as quickly as others and struggled to reach the professional performance standard, as described in the conceptual model. These students seemed to remain focused on their own performance of skills and demonstrated minimal evidence of significant patient awareness. As these students may have started at a lower level of reasoning ability, more time for development and additional exposure to patients with reflection and guided feedback could help enhance their learning. Some students simply became “stuck” at a particular level without the ability to further reflect and learn from the experience. Certain aspects of curricular design, such as a strong focus on skill development or testing for a right answer, could contribute to this problem. Early attention to psychomotor skill development may detract from a student’s ability to focus on patient-centered issues. Assessment of student performance in the first 2 to 3 semesters of the program in this study tends to be weighted heavily toward psychomotor skill development rather than clinical reasoning. Students who have difficulty progressing out of this stage may benefit from early learning experiences and assessments that help them consider the larger situational context of a patient’s problem as part of their learning experience.

While some students struggled with developing their clinical reasoning skills as the curriculum progressed, others exceeded expectations, as evidenced by the “outlier cases.” These students may have developed excellent reflective capabilities through structured experiences prior to professional education or may have been able to integrate and reflect on patient experiences at a comparatively advanced level throughout the program.

Limitations
The structure of the curriculum may have affected the outcomes. The early part of the curriculum, particularly the CCPE, focuses on procedural outcomes. Therefore, the students may have reflected accordingly. In addition, simple, straight-forward cases are presented initially in the curriculum followed by more complex cases and concepts. This may have influenced the students’ abilities to consider multiple patient factors in the beginning of the curriculum. A complete cohort of participants was not available in semester 8 due to the structure of the curriculum, as the CCPE is not a required component immediately prior to graduation. However, although the number of participants was less than previous semesters, the authors deliberately recruited participants with a range of academic abilities to provide a comparable sample.

CONCLUSION
Clinical reasoning is an essential skill for the preparation of competent, effective physical therapists. Currently, we know little about the development of this reasoning process in physical therapy students. Although we discuss how important the clinical reasoning process is in academic, clinical education, and clinical residency programs, we lack the tools to be able to identify and assess clinical reasoning skills. If the expectation is that student clinical reasoning skills will evolve and develop throughout the curriculum, learning experiences that target the development of critical self-reflection about student thinking or metacognitive skills should be intentionally integrated in didactic and clinical components of the educational program. In professional education, a learning environment exists that is often too focused on certainty or student formulation of the “right answer” versus engaging the student in serious critical analysis of his or her own thinking and learning process focused on her understanding of the uncertainty of the situation. Standards and expectations for each level of development of a student clinical reasoning process would be helpful in not only providing benchmarks for current expectations, but would place student performance explicitly within a continuum of competence. The results of this study provide insight into student learning at various stages of the curriculum. This information can guide pedagogical and assessment strategies to better facilitate clinical reasoning in physical ther-
apy education programs. Further research is needed to determine the best tools to assess clinical reasoning skills in physical therapy students, as well as strategies to facilitate the learning process in the didactic and clinical portions of the curriculum.

REFERENCES


Appendix A. Clinical Reasoning Reflection Questionnaire (CRRQ)

Presurvey

1) Thinking about your upcoming clinical competence performance examination (practical exam) with the selected patient case, how will personal factors including patient beliefs, perspectives, culture, attitude, socioeconomic status, and education be a part of your planned physical therapy examination and intervention?

2) Describe your thought process and initial impressions about the selected case you’ve been given for the clinical competence performance examination. What do you think the patient’s priorities from the physical therapist’s perspective could be that you would want to address?

3) What are the key physical therapy examination components (process of obtaining a history, performing a systems review, and selecting and administering tests and measures to gather data about the patient) that you want to perform? Provide specific details/examples for the exam categories of patient history, systems review, and test and measures and justify why you chose these components.

Postsurvey

1) If you were able to repeat this clinical competence performance examination experience, what would you do differently and why?

2) Based upon your interaction with the patient during the physical therapy examination and intervention piece of the clinical competence performance examination, how did you modify your plan of care or approach to this patient? Your answer may include personal factors such as patient beliefs, perspectives, culture, socioeconomic status, or education.

3) 
   a. List 2 tests and measures you choose to use with your patient.
   b. Justify your rationale for performing these tests and measures
   c. What information did you use to develop your physical therapy diagnosis or plan of care?

Appendix B. Clinical Performance Instrument “Clinical Reasoning” Dimensions

Applies current knowledge, theory, clinical judgment, and the patient’s values and perspective in patient management.

Sample Behaviors

a. Presents a logical rationale (cogent and concise arguments) for clinical decisions.

b. Makes clinical decisions within the context of ethical practice.

c. Utilizes information from multiple data sources to make clinical decisions (eg, patient and caregivers, health care professionals, hooked on evidence, databases, medical records).

d. Seeks disconfirming evidence in the process of making clinical decisions.

e. Recognizes when plan of care and interventions are ineffective, identifies areas needing modification, and implements changes accordingly.

f. Critically evaluates published articles relevant to physical therapy and applies them to clinical practice.

g. Demonstrates an ability to make clinical decisions in ambiguous situations or where values may be in conflict.

h. Selects interventions based on the best available evidence, clinical expertise, and patient preferences.

i. Assesses patient response to interventions using credible measures.

j. Integrates patient needs and values in making decisions in developing the plan of care.

k. Clinical decisions focus on the whole person rather than the disease.

l. Recognizes limits (learner and profession) of current knowledge, theory, and judgment in patient