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Exploring Clinical Reasoning in Doctor of Physical Therapy (DPT) Students Through Computer-Based Simulation

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Abstract

ABSTRACT

Purpose: Clinical reasoning is a critical skill required to be an effective clinician in today's dynamic and complex healthcare environment. Reflective ability is considered foundational for building clinical reasoning skills. The purpose of this mixed methods study was to explore the clinical reasoning strategies used by Doctor of Physical Therapy (DPT) students during a computer-based simulation and the relationship between the quality of reflection and clinical reasoning strategies used. Methods: Forty-five first (n=15), second (n=23), and third (n=7) year DPT students enrolled in six professional DPT programs in the United States participated in an asynchronous computer-based simulation designed to facilitate clinical reasoning and decision-making. The written responses to open-ended questions collected during the computer-based simulation and subsequent written self-debrief were analyzed qualitatively and quantitatively. Results: Students demonstrated the use of four main clinical reasoning strategies. More sophisticated reasoning strategies were observed in greater frequency among second and third-year students. The quality of reflection of the written responses to the self-debrief was variable. A correlational analysis using Fisher's exact test demonstrated there was not a statistically significant relationship between reflection quality and clinical reasoning strategy used during the simulation. Conclusions: Results were consistent with the findings of other studies that observed a progression along class years toward more sophisticated reasoning strategies with increased focus on the factors that contribute to patient impairments. Quality of reflection was not found to be associated with the clinical reasoning strategy used by participants. This highlights the need for additional research to determine the factors that impact clinical reasoning and reflective ability to inform the development of effective methods of instruction and assessment of these skills.

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Purpose: Clinical reasoning is a critical skill required to be an effective clinician in today's dynamic and complex healthcare environment. Reflective ability is considered foundational for building clinical reasoning skills. The purpose of this mixed methods study was to explore the clinical reasoning strategies used by Doctor of Physical Therapy (DPT) students during a computer-based simulation and the relationship between the quality of reflection and clinical reasoning strategies used. **Methods:** Forty-five first (n=15), second (n=23), and third (n=7) year DPT students enrolled in six professional DPT programs in the United States participated in an asynchronous computer-based simulation designed to facilitate clinical reasoning and decision-making. The written responses to open-ended questions collected during the computer-based simulation and subsequent written self-debrief were analyzed qualitatively and quantitatively. **Results:** Students demonstrated the use of four main clinical reasoning strategies. More sophisticated reasoning strategies were observed in greater frequency among second and third-year students. The quality of reflection of the written responses to the self-debrief was variable. A correlational analysis using Fisher's exact test demonstrated there was not a statistically significant relationship between reflection quality and clinical reasoning strategy used during the simulation. **Conclusions:** Results were consistent with the findings of other studies that observed a progression along class years toward more sophisticated reasoning strategies with increased focus on the factors that contribute to patient impairments. Quality of reflection was not found to be associated with the clinical reasoning strategy used by participants. This highlights the need for additional research to determine the factors that impact clinical reasoning and reflective ability to inform the development of effective methods of instruction and assessment of these skills.

Keywords: physical therapy, clinical reasoning, computer-based simulation

INTRODUCTION

Clinical reasoning has been described as an essential yet complex aspect of practice as a health professional.[1] Through Vision 2020, physical therapy (PT) became a doctoring profession adding the responsibility of autonomous practice and further emphasizing the need for sound clinical reasoning and decision-making skills.[2] Although clinical reasoning is considered critical to the PT profession, Christensen et al found that the way clinical reasoning was defined, instructed, and assessed was inconsistent among PT programs.[3] The absence of a shared understanding of this important construct has implications for how clinical reasoning is addressed in PT education and research.[4]

In a dynamic and increasingly complex healthcare environment, clinicians must develop the adaptive expertise required to create innovative solutions to novel and uncertain situations.[5] Schön's reflective practitioner model posits that professionals effectively adapt to these complex and uncertain situations encountered in practice through reflection in action.[6] Critical reflection, which Mezirow described as the challenging of premises, is a requirement for the transformation of perspectives characteristic of transformational learning.[7] Critical reflective skills are considered the foundation for the development of clinical reasoning.[8,9] Though the literature promotes reflection as a critical aspect of clinical reasoning, there is a dearth of research regarding the relationship between reflection and clinical reasoning in PT.

Simulation is a method that has been used to investigate clinical reasoning and reflection.[10-13] Simulation using virtual patients has been increasingly used in medical education to facilitate clinical reasoning.[14] Little in the literature addresses clinical reasoning in DPT students using virtual patients. This study explores the clinical reasoning strategies used by DPT students and the relationship between quality of reflection and clinical reasoning strategy use during a computer-based simulation. The research questions guiding this study were 1) What clinical reasoning strategies are used by DPT students during a computer-based simulation? 2) What is the quality of reflection among DPT students using a computer-based simulation? and 3) What is the relationship between the quality of reflection and clinical reasoning strategies used by DPT students during a computer-based simulation?

BACKGROUND

Clinical Reasoning

Clinical reasoning is a complex and multifaceted construct that is inconsistently defined. A lack of shared understanding of the concept of clinical reasoning could lead to inconsistency with instruction, assessment, and research.[4] A recent concept analysis of clinical reasoning in PT performed by Huhn et al concluded that clinical reasoning is contextual, iterative, collaborative, and integrates cognitive, psychomotor, and affective skills involving therapist and client perspectives.[4]

Much of the literature regarding clinical reasoning in PT discusses clinical reasoning strategies utilized by clinicians. A significant amount of PT clinical reasoning studies has been qualitative in nature comparing the strategies used by novice and expert clinicians. The two strategies most often discussed in the PT clinical reasoning literature are the hypothetico-deductive and pattern recognition strategies. The hypothetico-deductive strategy is most often associated with novice practice whereas pattern recognition is associated with expert practice.[1,15]

In addition to the hypothetico-deductive and pattern recognition strategies, Gilliland found additional clinical reasoning strategies used by DPT students during written case-based studies which included trial and error, following protocol, rule-in/rule-out, and reasoning about pain.[11,12] First-year students utilized trial and error, following protocol, and rule-in/rule-out more frequently while third-year students predominantly used the hypothetico-deductive and pattern recognition strategies. Reasoning about pain was observed across all class years in the studies. Gilliland and Wainwright observed the clinical reasoning patterns of protocol, hypothetico-deductive, pain (biomedical), pain (behavioral), and behavioral analysis in second-year DPT students during a standardized patient (SP) encounter.[13]

Clinical Reasoning and Reflection

Reflective ability is considered a foundational aspect required for the development of clinical reasoning.[1,8] Reflection on practice, specifically reflection in action, was found to be more prevalent in expert physical therapists than novice physical therapists, providing evidence that reflective skills are important for the development of clinical reasoning.[4,16] Wainwright et al also found that reflection in action was more prevalent in experienced clinicians as well as the ability to self-assess.[17] There is a paucity of literature addressing the relationship between reflection and clinical reasoning in DPT students. Furze et al theorized that the gradual development of clinical reasoning skills documented in DPT students over the course of a three-year DPT curriculum may have resulted from improvements in reflective ability.[8] Trommelen et al concluded that clinical reasoning in DPT students as measured by the Self-Assessment of Clinical Reflection and Reasoning (SACRR) and the Diagnostic Thinking Inventory (DTI) improved as a result of using written reflection assignments and case-based learning in a DPT curriculum.[18]

Technology-Enhanced Simulation and Clinical Reasoning

The International Nursing Association of Clinical and Simulation Learning (INACSL) Standards Committee has defined technology-enhanced simulation as "a simulation-based learning activity designed to provide an experience through the direct or assisted use of an electronic medium" including virtual simulation and computer-based simulation in this category.[19] Of the small amount of literature devoted to technology-enhanced simulation use in PT education there has only been a subset of studies involving technology-enhanced simulation and clinical reasoning. While there is little evidence to suggest that technology-enhanced simulation is a superior method of instructing clinical reasoning in PT students, studies have demonstrated that technology-enhanced simulation can effectively facilitate the development of clinical reasoning skills in this population.[20-22] To date, no studies have explored reflection and clinical reasoning strategies with DPT students using technology-enhanced simulation.

METHODS

Arocha and Patel suggested that the integration of methods within studies may provide a more complete understanding of clinical reasoning in PT.[23] The research design chosen for this study was a mixed methodology.

Subjects

DPT program faculty members were recruited to distribute a computer-based simulation to their students. Those DPT faculty who were willing to distribute the recruiting materials provided a link to the simulation to interested students via email. This study was approved by the Institutional Review Board at Binghamton University – SUNY. Faculty who agreed to help recruit students provided signed letters of agreement representing their institutions. The participants of this study were 45 first (n=15), second (n=23), and third (n=7) year students enrolled in six professional DPT programs in the United States. This was a purposive sample as participants were recruited for their appropriateness for this study to obtain maximal understanding of the phenomenon of clinical reasoning among DPT students using a computer-based simulation.[24] A concurrent design using identical samples was utilized as a mixed sampling scheme as all the participants contributed to the qualitative and quantitative phases of this study.[24]

Data Collection

Data collection and storage occurred through a computer-based interactive patient scenario delivered via the online survey tool Qualtrics. Prior to distribution, the computer-based simulation was subjected to a measure of content validity using a panel of experts and calculation of a content validity index (CVI). The simulation scenario consisted of a short question format where a series of clinical vignettes were followed by open-ended questions. The series of video vignettes portrayed an outpatient physical therapy evaluation of a patient who had undergone a total knee replacement (TKR) eight days prior. The scenario unfolded with each successive video clip and new information was delivered. The scenario, created with intentional diagnostic ambiguity, revealed that the patient is experiencing a new onset of calf pain. After the simulation scenario, participants participated in a self-debriefing where they were invited to answer open-ended, probing questions based on their experience of the simulation scenario. A reflection rating rubric created based on Mezirow's categories of reflection was utilized to categorize the reflection quality of each participant's responses to the debriefing questions.[10,25] In studies by Cook and Kleinheksel, measures of interrater reliability using the reflection rating rubric to rate participants' written responses were found to be adequate.[10,25]

Data Analysis

Student responses collected from the open-ended questions posed between the video vignettes were analyzed qualitatively. In addition to the primary researcher, a second coder was trained to code the data. Prior to coding, the coders met to discuss the literature regarding clinical reasoning strategies observed in DPT students that would be considered in the coding process.[11-13] In an iterative fashion, the coders remained open to the creation of additional codes if supported by the data.

As part of a PT evaluation, a clinician is expected to recognize patient cues through the process of taking a patient history and testing.[26] The interpretations derived from this information are considered hypotheses.[26] To assist in identifying clinical reasoning strategies, the prioritization of patient information and hypotheses generated by the participants were considered. Similar to the data analysis processes used by Gilliland and Gilliland and Wainwright, the data were coded in two cycles.[11-13] The first cycle of structural coding was used to code the patient history information and tests and measure categories the students prioritized during the simulation as well as the nature of any hypotheses generated.[27] The information prioritized from the patient history and evaluation tests and measure categories were based on the *Guide to Physical Therapist Practice 3.0*.[28] The hypotheses generated by the students were coded based on hypothesis categories established by Jones et al.[26] A second cycle of pattern coding was used to identify clinical reasoning strategies relating the nature of the hypotheses generated to the patient history information and tests and measure categories prioritized.[27] A random subset of the data was coded by the second coder. To ensure the coders were interpreting data in a similar fashion, interrater reliability was performed after a random selection of five responses was coded by each coder. An intercoder reliability index was calculated using Cohen's kappa. Kappa values calculated for the first cycle of structural coding ranged from .520 - .739 across the categories of information prioritized and hypotheses generated indicating a moderate to substantial level of interrater reliability.[29] For the second cycle of pattern coding, the calculated kappa value was .714 indicating a substantial level of agreement.[29] Consensus between coders was reached with discussion.

The data collected during the debriefing portion of the simulation were rated by the primary researcher using the reflection rating rubric.[10,25] A second rater rated a subset of the data. Before rating the data, the raters reviewed Mezirow's categories of reflection and discussed how to apply the rubric.[7] Responses were rated as either "nonreflection", "reflection", or "critical reflection". "Nonreflection" responses were characterized by a description of the experience without evidence of questioning or analyzing.[10,25] Responses characterized as "reflection" contained evidence of an analysis or evaluation of events in addition to a description.[10,25] To be considered "critical reflection", responses had to demonstrate that the participant recognized their own assumptions while exploring the reason challenges occurred and how to address them.[10,25] The raters first rated one set of student responses to the debriefing questions together and then each rated the same five additional student responses individually. The sample of five student responses were chosen at random and subjected to interrater reliability analysis using intraclass correlation coefficient (ICC). As raters were not randomly selected and individual scores were not used, ICC (3,1) was selected.[30] The calculated ICC (3.1) value was .882 (95% confidence interval) indicating good reliability.[31]

IBM SPSS Statistics for Windows, version 27 was used to conduct a correlational analysis to explore the relationship between the quality of reflection and clinical reasoning strategy used by DPT students during the computer-based simulation. As greater than 20% of the cells of the contingency table had expected frequencies < 5, Fisher's exact test was utilized in lieu of the Chi-squared test of independence.[32] The qualitative data of quality of reflection and clinical reasoning strategies were converted to dichotomous quantitative data (i.e., "1" and "0"), crosstabulation with 2 x 2 contingency tables were performed, and Fisher's exact test was used to assess the association between each category of quality of reflection and each clinical reasoning strategy used. As there was only one participant who demonstrated the "trial and error" strategy, they were excluded from the correlational analysis.

RESULTS

Information Prioritized and Hypotheses Generated

Figure 1 summarizes the prioritization of patient history information. The categories of patient history information most frequently prioritized by all class years were "current conditions" with a focus on the nature of the patient's pain and "activities and participation" related to the patient's current and prior level of function.[28] Figure 2 summarizes the categories of tests and measures prioritized. Most of the tests and measures categories prioritized by all class years related to biomedical properties. The most prevalent category of tests and measures prioritized across class years was range of motion (ROM) followed by muscle performance and circulation. Functional tests and measures such as gait, balance, and mobility were prioritized by all class years, however, this was observed more frequently in third-year students.

Figure 1. Prioritization of Patient Information Collected[a]

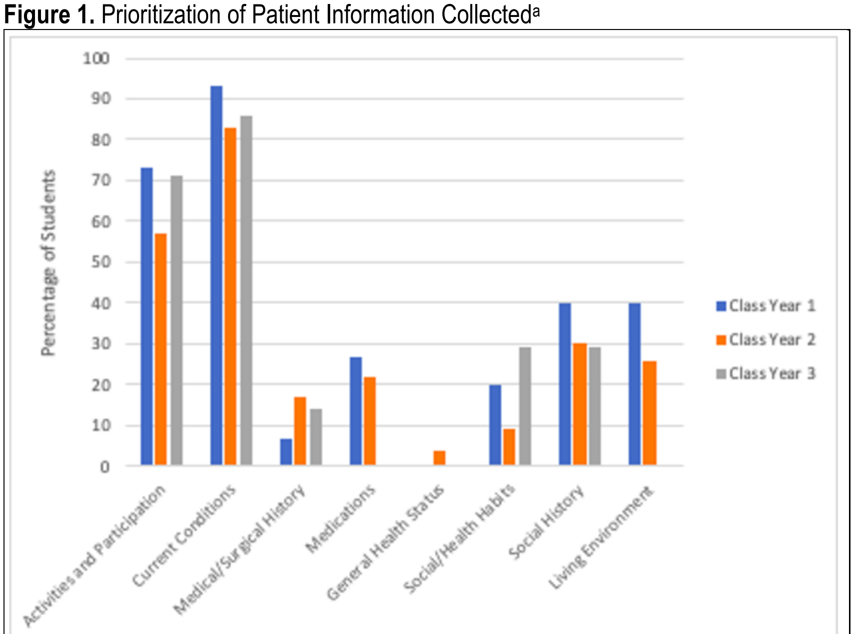

Figure 1 depicts the percentage of students who prioritized each category of patient information to be collected.
[a]Categories of patient information derived from the *Guide to Physical Therapy Practice* 3.0.[28]

Figure 2. Tests and Measure Categories Prioritized[a]

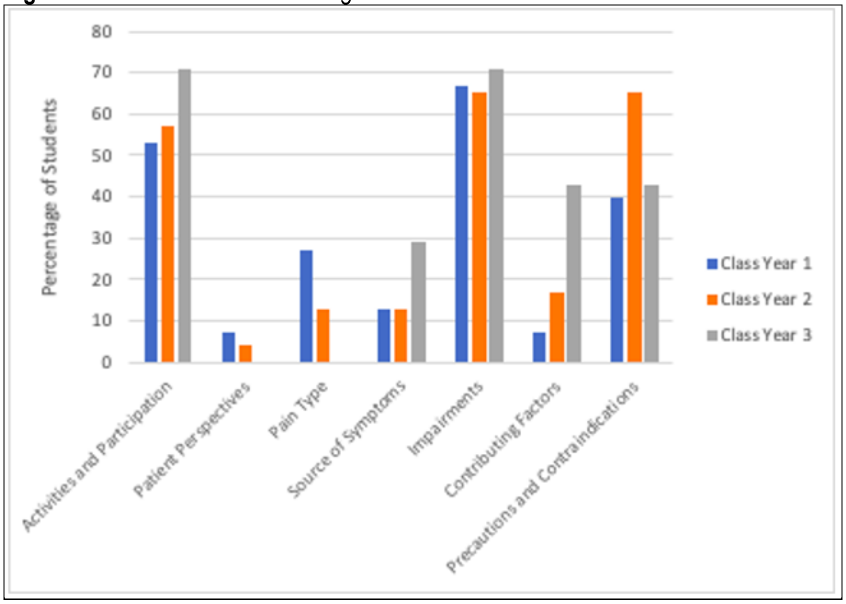

Figure 2 depicts the percentage of students who prioritized each category of tests and measures to be collected.
[a]Tests and measure categories are derived from the *Guide to Physical Therapy Practice 3.0*[28]

Figure 3 summarizes the hypotheses generated by the participants. The hypothesis category of "impairments in body structure or function" was observed frequently in all class years.[26] This was characterized by students who identified psychological, physiological, or anatomical structural and/or functional abnormalities.[26]

> Lack of strength in the right and left lower extremities with right knee manual muscle test and right and left hip abduction (are) the most concerning and with the presence of pain - she needs hip abduction for stability of (the) pelvis during gait and right knee strength back to ambulate without (a) walker.

While students across class years demonstrated hypotheses related to "activities and participation", this was observed in greater frequency in third-year students.[26] These hypotheses were characterized by concern for the patient's ability to participate in life situations.[26] One student answered, "Constant pain (is) a huge issue because (the) patient cannot properly return to activity with high constant pain."

A first-year student was the only participant who demonstrated a "patient's perspectives" hypothesis considering the patient's goals as part of the reasoning process.[26] The student explained:

> It seems that the patient's most limited ROM is knee flexion. I would want to work to increase that because loss of knee flexion ROM will affect gait. That is one of the patient's goals, to walk without a walker. So, by addressing knee flexion ROM we can start to work towards patient goals.

A greater percentage of second-year students generated hypotheses related to "precautions and contraindications".[26] One student expressed concern regarding the presence of a DVT stating, "The pitting edema, calf pain, and post-surgical risk factors raise significant concerns for DVT."

"Contributing factors" hypotheses, particularly those related to patient impact, were generated in higher frequency in third-year students.[26] One of the students expressed concern as to how the patient's pain level was contributing to physical and emotional disability commenting: "Constant pain (is) preventing (the) patient from functionally being able to do what she wants, causing anxiety and nerves and negative psychosocial factors." First and second-year students were more likely to focus on biomechanical contributing factors. This was evident as one student explained: "I think the highest priority is the knee ROM and gait; inability to fully extend or flex the knee during functional activity can lead to poor biomechanics which can re-illicit sciatica pain."

Figure 3. Hypotheses Generated[a]

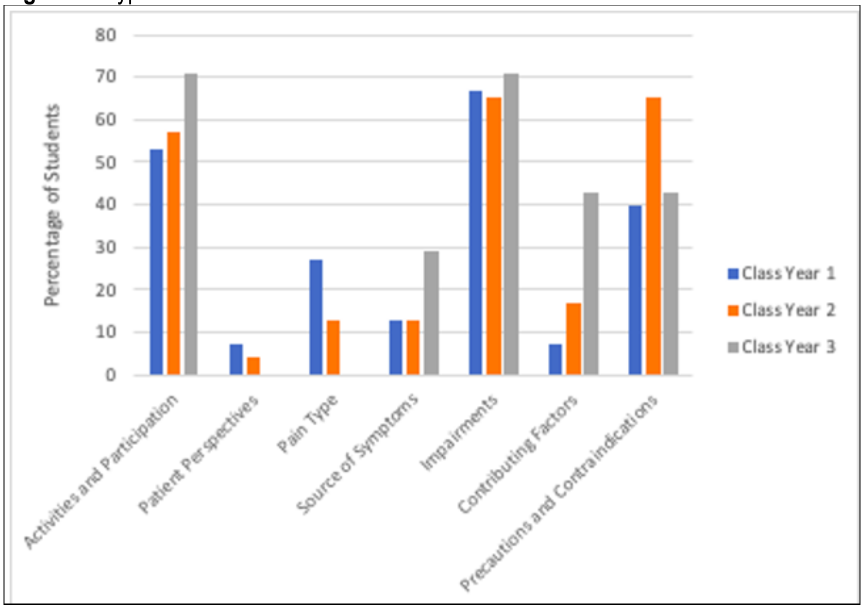

Figure 3 depicts the percentage of students who demonstrate each category of hypotheses.
[a]Hypothesis categories are derived from Jones et al.[26]

Clinical Reasoning Strategies

Students demonstrated the use of four primary clinical reasoning strategies including “trial and error”, “reasoning about pain”, “rule-in/rule-out”, and “hypothetico-deductive.”[11-13] Only one first-year student exhibited the “trial and error” strategy characterized by a lack of hypothesis generation suggesting multiple tests without a clear line of reasoning.[11,12] This student struggled to prioritize and rationalize use of tests and measures responding: “I would assume something similar to TUG (timed up and go) or 5 times sit to stand to assess performance, along with some balance testing to get a baseline, but I am not sure otherwise.”

“Reasoning about pain” was present in first and second-year students. Students demonstrating this strategy used the nature of the patient’s pain to guide their decision making.[11-13]

> The pain seems to worsen with most things - including time (from am to pm), with activity, and even post-operation. Additionally, the pain is always there and causing numbness and tingling. I feel it is a nerve related injury because of this.

The most common strategy observed was “rule-in/rule-out”. This strategy has been described as a “rudimentary version of the hypothetico-deductive process.”[11,12] Students who utilized this strategy demonstrated a hypothesis/test pattern.[11,12]

> [I would perform] functional tests, if any of them came back concerning, I would choose a more specific manual muscle test based off what I see. I might do a gait outcome measure such as FGA (functional gait assessment) or TUG (timed up and go) to see if she is at risk for falls. I might look at her balance, anticipatory/reactive control.

The “hypothetico-deductive” strategy was prevalent in second and third-year students, however, two first-year students demonstrated this strategy as well. Students who used this strategy articulated an organized plan for testing relative to hypothesis generation.[11-13]

> I would utilize palpation/observation to assess for point tenderness around the knee joint and to assess for presence of heat, redness and swelling regarding DVT screening. I may also utilize palpation at the low back and hip to assess for presence of residual sciatica, given the patient's history. I would additionally assess active and passive range of motion at the knee to assess the available motion following the replacement.

Figure 4. Clinical Reasoning Strategies Used[a]

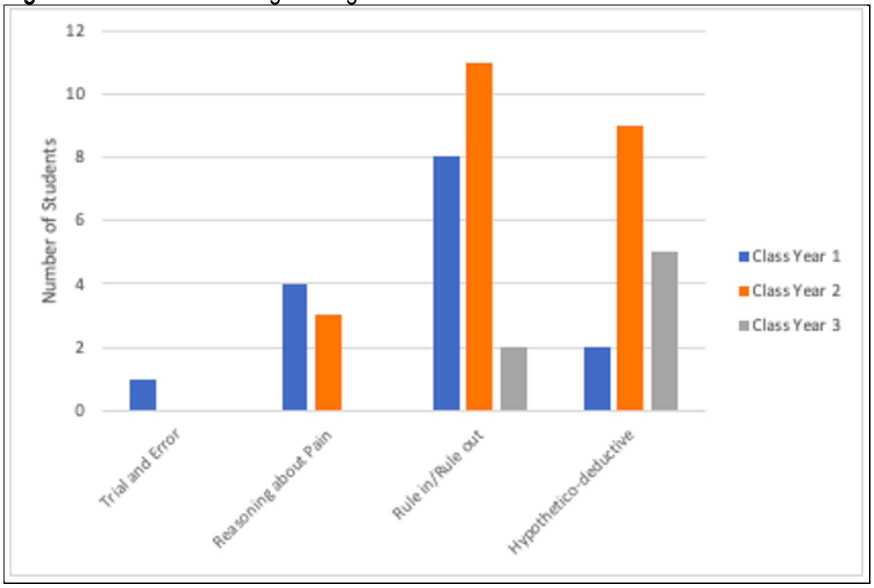

Figure 4 depicts the number of students who demonstrated the four main clinical reasoning strategies.
[a]Categories derived from Gilliland, and Gilliland and Wainright.[13-15]

Quality of Reflection

The quality of reflection of the written responses to the self-debrief was variable (see Figure 5). The category of "nonreflection" (n = 22) was the most prevalent, followed by "reflection" (n = 14) and "critical reflection" (n = 9). Reflection quality varied across class years. Of the nine participants who were categorized as "critical reflection", only one was a third-year student.

Figure 5. Quality of Reflection[a]

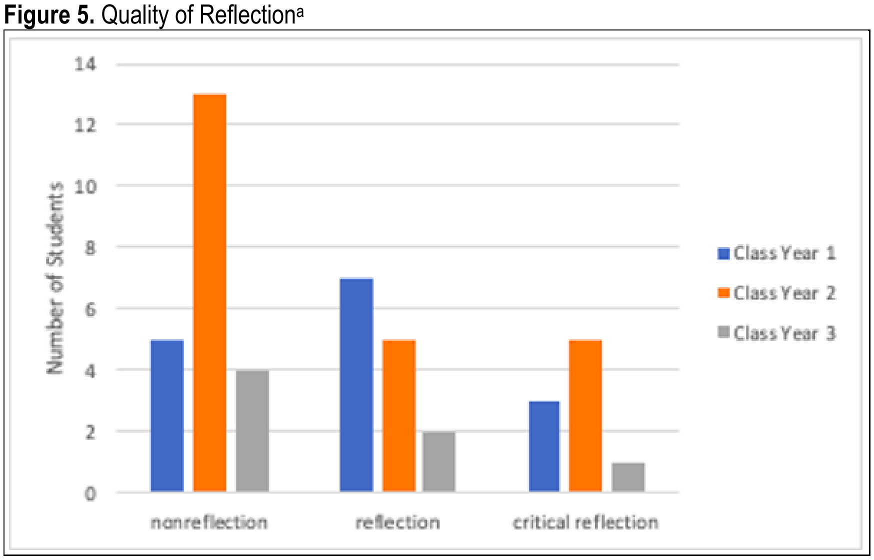

Figure 5 depicts the number of students who exhibited each category of quality of reflection.
aQuality of reflection calculated using the reflection rating rubric from Cook and Kleinheksel.[10,25]

Relationship between Quality of Reflection and Clinical Reasoning Strategy Use

A correlational analysis using Fisher's exact test examined the relationship between quality of reflection and clinical reasoning strategy. There was not a statistically significant association between the quality of reflection and clinical reasoning strategy used (see Table 1). The one student excluded from the analysis who demonstrated the "trial and error" strategy was categorized as "nonreflection".

Table 1: Two-Sided p-values for Quality of Reflection and Clinical Reasoning Strategies

Variables	Reasoning about Pain	Rule-in/Rule-out	Hypothetico-deductive
Nonreflection	.693	1.000	.761
Reflection	1.000	1.000	1.000
Critical reflection	1.000	1.000	.702

DISCUSSION

Clinical reasoning skills are essential to practice as an effective clinician in a dynamic and complex health care environment. However, clinical reasoning remains a complicated and multifaceted phenomenon making it difficult to determine appropriate instructional and assessment practices to facilitate the development of clinical reasoning skills. The aim of this study was to explore the clinical reasoning strategies used and assess the relationship between the quality of reflection and clinical reasoning strategy used by DPT students during a computer-based simulation. The participants of this study demonstrated a progression of clinical reasoning with time in a DPT curriculum. Consistent with the results of other studies, students used clinical reasoning strategies that were more sophisticated as they approached their final year of professional studies.[8,12,13] Though demonstrated in two first-year students, the more organized "hypothetico-deductive" strategy was observed more frequently in second and third-year students. These results provide support for a developmental progression of clinical reasoning in DPT students. A priority has been placed on the development of entrustable professional activities (EPAs) for the PT profession to minimize unwanted variation in practice.[33] Knowledge about the progression of clinical reasoning development in DPT students can inform the creation of EPAs related to the domain of clinical reasoning in PT.

While studies have found that DPT students and novice physical therapists tend to rely more heavily on external resources such as protocols and forms, there was no direct evidence of a "following protocol" strategy among the participants of this study.[11,13,34] However, there was mention of obtaining "baseline" measures as a rationale for tests and measure prioritization by nine students. This occurred primarily in first and second-year students and was mentioned by one third-year student. Reliance on tests for the purpose of establishing a baseline in somewhat of a routine manner could suggest some form of rigidity in thinking through the evaluation process characteristic of those who are reliant upon evaluation forms or protocols.

Similar to other studies, participants used clinical reasoning strategies that exemplified "PT-specific" reasoning about movement and underlying biomechanical causes of symptoms.[12,13] While students in all class years generated hypotheses about impairments in similar numbers, hypotheses that focused on contributing factors were seen more frequently in third-year students. Consistent with the findings of Gilliland, this demonstrates a shift in focus from the "what" to the "why."[12] Of the students who generated "contributing factors" hypotheses, third-year students more frequently considered patient impact rather than biomechanical causes alone. Though "reasoning about movement" was not demonstrated as a primary clinical reasoning strategy by the participants of this study, attention to movement was evident in the prioritization of information and hypothesis generation of many of the students. Focus on movement during evaluation has been found to be present in DPT students, as well as novice and expert physical therapists.[13,35] ROM was the tests and measure category most frequently prioritized by all participants in this study. Of the students who discussed movement analysis, over half did so from a behavioral perspective expressing concerns about the impact of abnormal movement on the patient's current level of function. The remainder of the students analyzed movement from a strictly biomechanical perspective. Similarly, Gilliland and Wainwright found evidence of the biomechanical and behavioral approaches to reasoning about movement in a study of second-year DPT students.[13]

In contrast to prior studies that have identified a lack of patient-centered clinical reasoning in PT students, many participants in all class years demonstrated consideration of the patient's findings on her activity and participation capabilities and restrictions.[8,12,13] Though observed more frequently in third-year students, "activities and participation" hypotheses were generated by approximately half of the first-year students. Students in all class years prioritized patient history information related to patient function, particularly in the activities and participation category. The two students who generated "patient perspectives" hypotheses were in their first and second years. A first-year student was the only participant to link the reasoning process directly to the patient's goals. This focus across class years on patient impact in prioritization of information and hypothesis generation could suggest that a more patient-centered clinical reasoning pattern is emerging in DPT students. It has been recommended that patient-centered care should be prioritized as a shared value in all clinical and academic settings.[36] The results of this study may suggest that efforts to facilitate patient-centered reasoning across DPT curricula in recent years have been successful. It may also provide evidence that the influence of curriculum on clinical reasoning may supersede previously considered student level factors such as academic and cognitive capacity, student perspectives, background, and prior experiences.[12,13]

Evidence of critical reflection did not necessarily increase in frequency as class year progressed. This contrasted with the findings of Furze et al who found that student reflections increased in depth and insight as students progressed through a DPT curriculum.[8] Reflection has been found to decrease in clinicians with increased years of experience potentially due to fewer feelings of uncertainty.[37] Though the computer-based simulation used for this study was structured with diagnostic ambiguity intended to create a sense of uncertainty, it is possible that it did not elicit the challenging of prior assumptions required to facilitate critical reflection in all participants.[7] However, none of the participants exhibited a clear "pattern recognition" strategy indicating their hypotheses were based on prior experience.[11,12] Of the student responses that lacked evidence of critical reflection, several demonstrated an external attribution of blame when reflecting on their "performance" during the simulation, criticizing the actions of the physical therapist in the vignettes or the format of the simulation. Consistent with the findings of Furze et al that students earlier in the DPT curriculum tended to exhibit a limited acceptance of responsibility progressing toward greater contextual and situational awareness over time, this external focus was observed primarily in first and second-year students and was evident in only one third-year student.[8]

Like clinical reasoning, reflective ability is essential to clinical practice as it impacts patient outcomes.[17] There was variability in the quality of reflection captured during this simulation. Instructional methods considered effective in facilitating reflection include those that create a respectful and supportive learning environment, link the activity to the learning objectives, provide examples of good critical reflections, and allow time for reflection.[17,38] While this learning experience was linked to explicit learning objectives and administered in a non-threatening, anonymous manner, it may have been inconducive to reflection in other ways. Proper modeling of or explicit instructions regarding written reflection responses were not provided to the students prior to this activity. Also, the amount of time students allotted for this activity was unknown. Students volunteered to participate in this simulation in addition to their required coursework during the spring semester. As the DPT curriculum is demanding, participants may not have set aside adequate time to reflect during this activity.

Limitations and Future Research

There are multiple limitations to this study. As it can be challenging to balance sample size to satisfy appropriate sizes for the qualitative and quantitative components of a study, optimally, the sample size should be large enough to have satisfactory statistical power, yet not so large as to overwhelm the researcher during the qualitative data analysis.[24] The sample size of 45 participants limits the generalizations that can be drawn from the quantitative component of this study. Due to the case-specific nature of clinical reasoning, the ability to generalize results from the use of one interactive patient scenario is limited.[39] As reflection is an invisible, multifactorial, and contextual construct, it is inherently difficult to measure.[40] There is the possibility that using a different tool for reflection assessment would produce different results.

Reflection is an essential aspect of learning and accepted as foundational to the development of clinical reasoning, however, there are factors other than reflection that may affect clinical reasoning strategy use in DPT students.[8] The construct of clinical reasoning is highly contextual.[4] The high numbers of "precautions and contraindications" hypotheses generated during this simulation may demonstrate this contextual influence. As students from six different institutions participated in this study, there may have been programmatic differences that were unaccounted for in this research design. There may also be other student-level factors such as approach to learning and life experiences outside of work or clinical experience that influence clinical reasoning strategy use. More research is required to determine the factors that impact clinical reasoning and reflective ability to inform the development of effective methods of instruction and assessment of these skills.

CONCLUSION

This study analyzed the clinical reasoning strategies used by multiple students from six DPT programs in class years one through three during an asynchronous computer-based simulation. Consistent with the findings of other studies that have explored clinical reasoning strategies in DPT students, a progression along class years toward more sophisticated reasoning strategies with increased focus on the factors that contribute to patient impairments was observed. In contrast to the findings of other research, many of the students across class years focused on patient activity and participation level factors, serving as potential evidence of the acceptance of a biopsychosocial model. An association was not identified between the quality of reflection and clinical reasoning strategy used by the participants of this study. This highlights the need to research other potential influences on clinical reasoning such as curriculum design and other student-level factors such as approach to learning. This study provides further insight into how students' clinical reasoning skills progress over the course of DPT curricula. Understanding the developmental progression of clinical reasoning can assist educators with implementing effective instructional and assessment strategies as well as informing the creation of developmental milestones to help to determine competency levels. It is important to identify instructional methods capable of enhancing clinical reasoning and reflective ability as they are critical to the development of adaptive expertise and proficient expert practice.

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