Tracking Change in Critical-Thinking Skills

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Background and Purpose. Critical thinking, knowledge, skill, and self-reflection are the hallmarks of clinical reasoning in physical therapy. Teaching and measuring a highly complex entity such as clinical reasoning is a challenging task and often requires multiple pedagogies and assessments. Knowledge and skill are frequently assessed by educators, but critical thinking and skills of reflection are not. Previous studies have used standardized tests to assess clinical reasoning skills of physical therapist students. These studies report conflicting findings potentially due to the fact that neither test was designed to test critical thinking of allied health practitioners. The Health Sciences Reasoning Test (HSRT) was designed specifically for health science students with questions written in a health care context.

Participants. In 2008, 63 students, 37 from a public East Coast university and 26 from a private Midwest university were recruited to complete the HSRT.

Method. The students completed the HSRT at 3 points in their education: upon entry to the program, prior to final affiliations, and again just prior to graduation.

Outcomes. Analysis indicated a statistically significant change for the total score as well as the deductive and analysis subscales. Post-hoc analysis indicated these differences occurred between times 1 and 2 for the total score as well as both subscales. There was a significant difference between the 2 schools after adjusting for variance in initial test scores. The Midwest school's mean score (24.85) was greater than the east coast school's (22.42), and this difference was significant $F_1 = 12.65$; $P < .05$.

Conclusion. The HSRT was able to detect change in critical thinking scores. This finding, coupled with those of a previous study in which the HSRT was able to detect differences between experts and novices, indicate the HSRT may have validity and therefore may be a useful tool for assessing the critical thinking skills of physical therapist students.

Key Words: Assessment, Clinical reasoning, Critical thinking.

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INTRODUCTION

The Commission on Accreditation of Physical Therapy Education (CAPTE) requires physical therapist education programs to develop and assess students' clinical reasoning skills.[1] While clinical reasoning skills have always been an important component of physical therapist education, this mandate, coupled with direct access and the move to a doctoring profession, increases the importance of teaching and assessing clinical reasoning skills of physical therapist students.

Clinical reasoning refers to the thinking and decision-making process used during examination and management of patients.[2] It is a complex mechanism that requires basic scientific knowledge, clinical competence, the ability to self-reflect, and critical thinking skills. *Critical thinking* is the disciplined, intellectual process of applying skillful reasoning as a guide to belief or action and involves the cognitive abilities of analysis, interpretation, inference, evaluation, and explanation.[3] The relationship between critical thinking and clinical reasoning is poorly understood and the terms are often interchanged. Clinical reasoning can be conceptualized as critical thinking within a specific domain or a particular point of view of a field, in this case the field of physical therapy. Physical therapists apply the components of critical thinking about and within the field of physical therapy, which has a certain point of view. This point of view is based on the objects, events, and investigations we consider in our area of expertise.[4] The result of this critical thinking within our domain of practice and within the point of view of the field can be considered clinical reasoning. If one accepts this postulate then the skills required for critical thinking (ie, analysis, interpretation, inference, evaluation, and explanation) would be considered inherent in the clinical reasoning process but would be used contextually within the domain of physical therapy. Not all of the component skills used in clinical reasoning (ie, critical thinking, reflection, domain, context, perspective, etc) are amenable to objective measurement, thereby limiting the assessment of clinical reasoning to what can be readily measured: critical thinking skills.

The study of the development of clinical reasoning skills in medical education suggests expert practitioners, through repeated practice, develop scripts or schemas to ease the cognitive load of managing frequently seen patient scenarios.[5] In other words, when evaluating common patient problems practitioners rely on automaticity rather than analytic thinking. An expert, however, will be able to pay sufficient attention to the particular problem being evaluated and switch to analytical thinking when he or she identifies

an aspect that may indicate the problem is not the same as ones previously seen.[6] It is at this point that critical thinking skills become paramount. The ability to think critically allows for reasoned consideration of context, theories, evidence, and criteria inherent in the case in order to make a purposeful judgment about what to think or do.[7] Novices do not have the benefit of multiple years of experience to develop the scripts that lead to automaticity. Each patient case is novel to them and requires high cognitive demand, which necessitates heavier reliance on their analytical or critical thinking skills.[8,9]

Measuring a highly complex entity such as clinical reasoning is a challenging task and often requires multiple assessments. In the absence of a single tool to measure the entire reasoning process, educators often rely on measuring component skills. Previous studies have used standardized tests such as the Watson Glaser Critical Thinking Appraisal (WGCTA) and the California Critical Thinking Skills Test (CCTST) to assess critical thinking skills of physical therapist (PT) students. These studies report conflicting findings, potentially due to the fact that neither test was designed to test critical thinking of health care practitioners. The WGCTA was written to assess critical thinking skills required for business, while the CCTST was written to assess general critical thinking skills. The Health Science Reasoning Test, written by the authors of the CCTST, was designed specifically for health science students with questions written in a health care context.[10]

We hypothesize, given clinical reasoning is critical thinking within the context of the domain of health care, and the test questions are written in the health care context, the HSRT will be able to measure changes in critical thinking skills of physical therapist students as they progress through an entry-level DPT education program. The purpose of this research was to evaluate the ability of a new tool, The Health Sciences Reasoning Test's (HSRT) ability to measure change in critical thinking skills over time.

Review of the Literature

Standardized tests of critical thinking have been used in the past to assess critical thinking skills of physical therapist students. One such test is the Watson Glaser Critical Thinking Appraisal (WGCTA), which measures inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments and has been found to have a reliability of .74–.81.[11] The California Critical Thinking Skills Test (CCTST) has been used to test critical thinking skills in physical, occupational, and respiratory therapy, as well as dietetics, pharmacy technology, and nursing students. It measures analysis, evaluation, inference, and inductive and deductive reasoning. Reliability coefficients have been reported at .68–.69.[12] Both of these tools have been used as outcome measures in studies in physical therapy; however, differences in methodology and outcome measures limits the ability to draw a conclusion regarding changes in critical thinking of physical therapist students. Studies using the WGCTA and the CCTST have described conflicting results with some studies reporting a change and others not. There have been 5 studies in physical therapy: 1 using the Watson Glaser and 4 using the CCTST.[13-17] Wessel and Williams[16] and Vendrely[15] studied Master of Physical Therapy (MPT) students, Wessel and Williams at the beginning and end of the academic year and Vendrely at entry into the program and upon completion of the program. Neither reported significant changes in CCTST scores. Each found the pretest scores of the cohorts were at the higher level of the norms reported for the test. At pretest, Wessel and Williams' subjects scored in the 60th percentile, while Vendrely's scored in the 80th. Authors of both studies suggested a possible ceiling effect as an explanation for the lack of significant change in CCTST scores.[15, 16]

In contrast, Bartlett and Cox[13] and Zettergren and Beckett[17] reported significant changes in CCTST scores in studies of undergraduate and masters prepared PT students. Data were collected at 3 time points, at the beginning of the program, at the end of the didactic portion of the program, and again between years 2 and 3 of the program. Significant improvements were noted at each testing point with the greatest difference reported between the didactic and clinical portions of the program.[13,17] Cech administered the WGCTA to a cohort of MPT students at 3 points during their education and reported statistically significant increases in the inference and deductive subscale scores between the first and third administrations of the test. Consistent with the findings of Bartlett and Cox,[13] the improvements were noted after the students participated in clinical affiliations.

Neither the WGCTA nor CCTST were designed specifically to assess skills of health care providers but rather to assess general critical thinking skills. It is believed that expert clinical reasoning skills are context dependent; therefore, a tool that uses the context of health care may prove more appropriate for testing critical thinking skills of health care practitioners.[18] Insight Assessment recently developed the Health Sciences Reasoning Test (HSRT) specifically to assess critical thinking skills of allied health students. Specific domain knowledge is not required to answer items on the test, but the questions are written in a health care context. Questions are designed to test aptitude for analysis, making an inference, evaluating an inference, and justifying an evaluation or inference. Table 1 provides the descriptions of each of the subscales.[19] A total score as well as subscale scores are provided.

PARTICIPANTS

In 2008, all first-year students from 2 accredited Doctor of Physical Therapy programs (n = 79) consented to participate. Six from each school were lost to incomplete data, leaving 63 students, 37 from a public east coast university and 26 from a private Midwest university who completed the study. Using subjects from 2 schools provided a more representative pool (private vs. public university, geographically different) of physical therapist students thereby increasing the generalizability of the findings. Table 2 provides participants' demographic data. Students were well matched in GRE and grade point average (GPA) scores at initiation of the study.

METHODS

Upon entry into the physical therapist education program, all students consented to complete the HSRT at 3 time points: (1) at entry into the program, (2) prior to final year

Table 1. HSRT Subscale Descriptions

Scale	Definition
Induction	Drawing probabilistic inferences regarding what is most likely true or not true
Deduction	Conclusion cannot be false if the premise is true
Inference	Ability to draw conclusions based on reasons and evidence
Analysis	Closely examine ideas; identify assumptions, reasons, claims; and gather detailed information
Evaluation	Address the credibility of claims and the strength and weakness of arguments

Table 2. Descriptive Data

					Undergraduate Degree			
	Male/Female	Mean Age	Mean GPA	Mean GRE	Biology	Exercise Physiology	Kinesiology	Other
Midwest School	7/19	23	3.52	1080	3	7	2	14
East Coast School	9/28	24	3.35	1092	12	3	1	11

affiliations, and (3) prior to graduation. This study was approved by the institutional review boards of both institutions involved in the study and students provided informed consent. Subjects were told the test results would not be graded as part of coursework, but would be used to monitor their progress in the program. All subjects completed the tests at their respective schools in an on-campus computer lab. One faculty member from each school monitored all 3 test experiences. At the first test, each student was given an index card with a unique login to access the test. These cards were collected by the faculty member after completion of the first test and redistributed each successive testing date. The login information was coded so a student could not be identified by the login data alone. Subjects were given an unlimited amount of time to complete the tests, but data regarding time to complete were not collected. Test scores were calculated and stored by the company that produces the HSRT. Investigators did not review scores until after completion of the third test, at which time a spreadsheet with each subject's 3 scores was downloaded and used for analysis.

Data Collection Tool

Content validity of the HSRT is based on a 1990 Delphi study on critical thinking that describes the findings of the 2-year project designed to reach a consensus definition of critical thinking, including its core cognitive skills.[6] Normative data for graduate students has been established with a mean score of 22.61 for the overall score. A total score of 30 is possible with a score of 25 or higher indicates strength in critical thinking while a score below 15 indicates weakness.[19] In previous work,[20] the authors established construct validity of the HSRT by assessing the ability of the test to detect differences between expert and novice physical therapists. In that study, 80 first-year Doctor of Physical Students from 2 programs and 73 certified clinical specialists (orthopedic, neurologic, and geriatric) completed the test. The test was able to identify differences between experts and novices (t_{148} = -2.67, P = .008) for the total score as well as the deduction ($F_{1,150}$ = 5.96, P = .01) and analysis subscale ($F_{1,150}$ = 12.94, P < .001) scores.[20]

Data Analysis

Data analyses were completed using SPSS (version 19.0.1).[21] Prior to analysis data were explored to ensure assumptions for inferential analyses were met. The HSRT's ability to measure change over time was tested using a 1-way repeated measures analysis of variance (RMANOVA) and Bonferroni post hoc tests.

Although not the original intent of the study, we decided to also determine if subjects from the 2 schools progressed equally. Since we were now interested in between school differences, it was important to look at baseline differences between schools. An independent sample t test indicated the 2 schools were not equal at baseline; the Midwest school's scores (μ = 23.50) were higher than those of the East Coast school (μ = 21.62) and this difference was significant (F_{61} = .778, P = .03). It is interesting that there was difference in HSRT test scores at time 1, as there were no significant differences between the schools regarding age or GPA or GRE scores. To account for this difference, the data were transformed to Z scores and a repeated measure ANOVA was conducted using the Z scores.

OUTCOMES

The mean score for each testing time and F statistics of the subscale and total scores for all subjects are presented in Table 3. Analysis indicated a statistically significant change for the total score as well as the deductive and

Table 3. HSRT Total and Subscale Means at Times 1, 2, and 3, and ANOVA Statistics

	Time 1	Time 2	Time 3	F	P
Total Score	22.39	23.74	23.42	7.81	.007[a]
Inductive	7.9	8.14	8.27	2.27	.13
Deductive	7.15	7.87	7.5	11.14	.001[a]
Analysis	4.23	4.71	4.73	9.25	.003[a]
Inference	3.57	3.63	3.42	0.891	.69
Evaluation	5.2	5.33	5.39	1.03	.31

[a]P < .05.

analysis subscales. Post hoc analysis indicated these differences occurred between times 1 and 2 for the total score as well as both subscales. Post hoc analyses are presented in Table 4.

The main effect for school was significant, $F_1 = 144.57$, $P < .001$. Table 5 provides the Z Scores by school for each time point.

DISCUSSION AND CONCLUSIONS

We hypothesized that the HSRT, designed for health care students and written in the context of health care, would measure changes in critical thinking of physical therapist students. The HSRT was able to detect change in critical thinking scores; thus the hypothesis is accepted. This finding, coupled with those of a previous study in which the HSRT was able to detect differences between experts and novices, indicates the HSRT may have validity and therefore may be a useful tool for assessing the critical thinking skills of physical therapist students. We cannot say with certainty that the differences detected were due solely to the contextual nature of the test questions of the HSRT. Repeating the study having subjects complete both the CCTST and the HSRT at the same time points might provide a more definitive answer. However, given that the HSRT was able to measure changes, it seems prudent to use a test written in a health care context rather than those that are not.

Our findings indicate the greatest changes in clinical reasoning skill occurred during the didactic portion of the students' education, not during clinical rotations. This finding is contrary to that of Bartlett and Cox,[13] who reported a greater change in critical thinking scores during the clinical portion of their program relative to the didactic portion. A more recent study of medical school curriculums by Williams et al[22] reported similar findings to ours, describing a steady improvement across the years of medical school, but failed to identify greater improvement during the clinical portion of the program compared to the didactic portion**.** The study included 5 different medical schools and, although they hypothesized there would be a difference between traditional and integrated curriculums, this hypothesis was not supported.

Potential reasons for the difference in scores between the 2 programs raises several questions and identifies areas for future research regarding exploration of DPT program curriculums. It was not the original intent of this study to compare curriculums, so we can only speculate regarding potential reasons for the differences found between schools. Several curricular differences exist between the 2 schools, including overall length of the programs, timing and length of affiliations, and structure and content of courses. Figures 1 and 2 illustrate the 2 curriculums.

A substantial difference between the programs is the timing and placement of clinical experiences. There is a difference of 4 weeks of clinical experiences, with the East Coast school having 42 weeks and the Midwest school 46 weeks. There is also a difference in the timing of those experiences in the curriculum. The Midwest school has an additional 2 weeks of clinical experience in the second year that the East Coast program does not. Perhaps the additional 2 weeks provides an opportunity for students to contextualize the knowledge gained in classes, whereas the East Coast program students do not get that opportunity until the end of year 3. We know skills, whether psychomotor or cognitive, are better learned when practiced in a contextual setting.[23] Additionally, the HSRT test questions are written in a health care context, so perhaps those extra weeks of clinical affiliations exposed the students to situations that helped with the context of the test questions. Further studies regarding the impact of timing and length of clinical affiliations may provide insight regarding this hypothesis.

Another difference between the programs is the type and frequency of written and practical comprehensive exams. While both programs require students to pass comprehensive practical exams, the frequency of these exams varied between the 2 schools. The Midwest school requires students to perform satisfactorily on a practical exam at the completion of each semester. The East Coast school has comprehensive practical exams, but only at 3 time points in the curriculum. Perhaps the frequency of the practical exams requires students to integrate material on a more regular basis, thereby "chunking" information together as a precursor to pattern recognition. The East Coast school does not use comprehensive written exams, whereas the Midwest school uses them each semester.

Table 4. Bonferroni Comparison for Significant Change Scores

	Mean Difference	SE	95% Confidence Interval	
			Lower Bound	Upper Bound
Total Score Time 1 to Time 2	1.39[a]	0.418	-2.37	-0.321
Total Score Time 2 to Time 3	0.317	0.365	-0.582	1.21
Deductive Score Time 1 to Time 2	0.714[a]	0.214	-1.24	-0.188
Deductive Score Time 2 to Time 3	0.365	0.203	-0.134	0.864
Analysis Score Time 1 to Time 2	0.476[a]	0.157	-0.861	-0.091
Analysis Score Time 2 to Time 3	0.016	0.135	-0.348	0.316

[a]$P < .05$.

Table 5. Z Scores

School	Time 1	Time 2	Time 3
East Coast	14.71	15.55	15.85
Midwest	23.28	21.12	15.30

Figure 1. Creighton DPT Curriculum

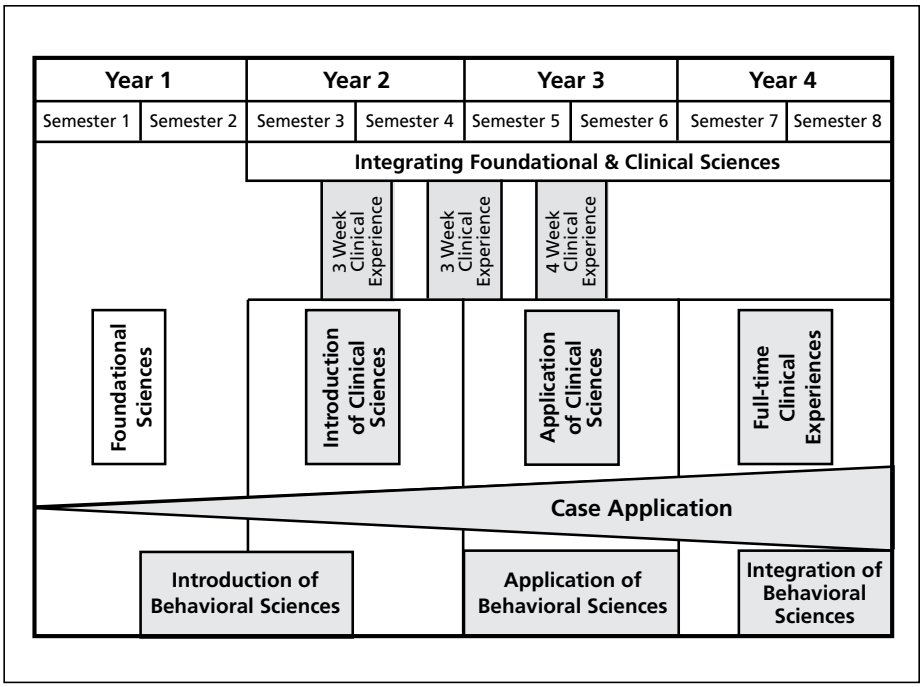
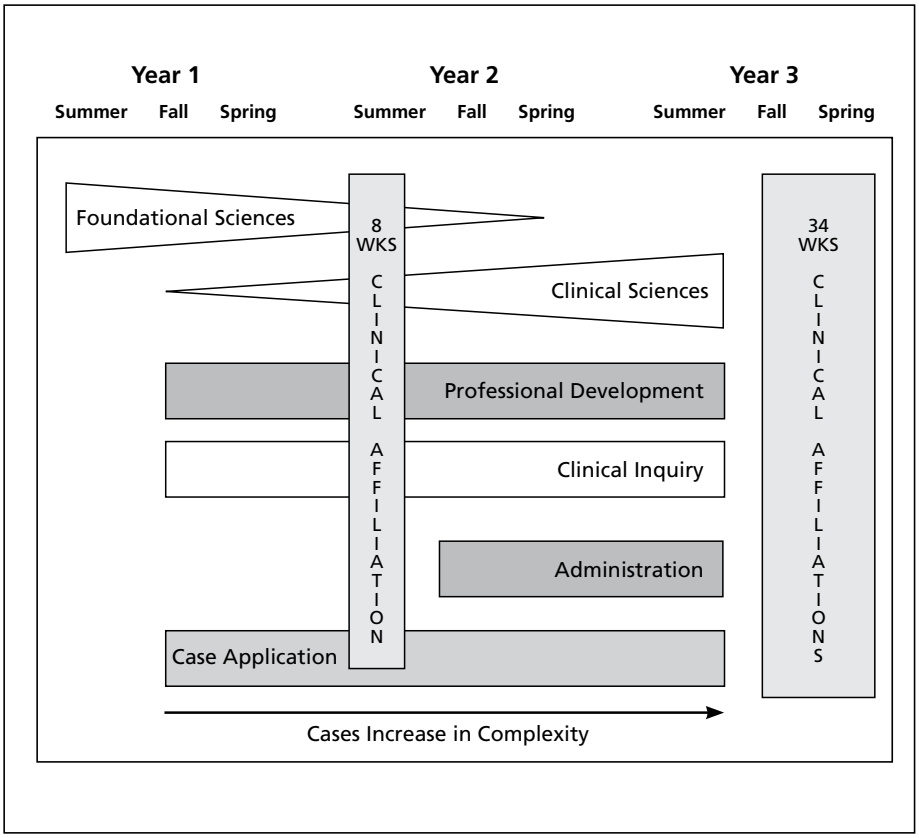


Figure 2. UMDNJ DPT Curriculum



It is possible that the comprehensive exams encourage a greater amount of integration of material, thereby requiring evaluation and analysis of information in the exam questions. Additionally, the construction of comprehensive exams requires discussion amongst faculty, which may facilitate the integration of material across courses, which again may lead to a higher level of analysis and evaluation of material.

We believe this study is a first step in the substantial work that needs to be done regarding the teaching and assessment of clinical reasoning. The study raises questions as to what are best practices in teaching clinical reasoning? The Commission on Accreditation in Physical Therapy Education (CAPTE) mandates that clinical reasoning skills be developed and measured, but there is little evidence as to what pedagogy best accomplishes this mandate. Do the number and timing of clinical experiences impact the development of clinical reasoning skills? The physical therapy literature regarding the timing and weeks of clinical experiences is minimal. There is substantial variation in clinical experiences required by physical therapist education programs. According to a communication shared by a member of the New York/New Jersey Clinical Education Consortium, programs report a range of clinical exposure from 32 to 42 weeks, indicating some students are potentially receiving 10 fewer weeks than others.

This study evaluated a single component of clinical reasoning: critical thinking. While critical thinking skills are important, metacognition and self-reflection are equally or even more important. Although there was a difference in critical thinking skills between the 2 schools, we cannot say for certain that there is a difference in clinical reasoning skills, as we only studied the critical thinking component. However, if there is a difference in critical thinking skills, would there be differences in other skills such as reflection and metacognition as well? In conclusion, the HSRT may be an effective tool to measure the critical thinking component of clinical reasoning of physical therapist students.

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