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## Development of Critical Thinking in Pharmacy Education

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**Keywords:** critical thinking, development, assessment, California critical thinking skills test, defining issues test, habits of mind

### Abstract

*The concept of development is ubiquitous throughout higher education. Development of critical thinking, problem-solving, and clinical reasoning are noted as important outcomes in higher education, including health professions education. In this era of widening scrutiny, demonstration of this outcome within programmatic assessment is becoming increasingly important. Programmatic assessment of critical thinking is complicated because of its multiple definitions, array of theoretical frameworks, and variety of measurement instruments. Additionally, recent guidelines and standards for pharmacy education have affirmed "habits of mind," which are not new to education and encompass analytical critical thinking. In this paper, we sought to provide: 1) an overview of various critical thinking measurement instruments with their different associated critical thinking definitions, 2) a background and framework for thinking using the Dimensions of Learning model, 3) implications and applications for assessing cognitive development (critical and complex thinking) within the context of pharmacy education, and 4) specific suggestions for assessment in pharmacy education.*

### INTRODUCTION

In the hallways and offices of pharmacy education, faculty often use the term "critical thinking." For example, faculty may refer to critical thinking (CT) when discussing how their students need to make tenable assumptions for a patient case, or choose a best therapy from among treatment options for a patient's specific circumstance. However, not all *good thinking* should be lumped into "critical thinking"; just like in other areas our language and choice of terms is essential. In this paper, our innovation is to highlight the Dimensions of Learning framework for cognition—to better understand "critical thinking"—and to discuss its applications, as well as implications, for pharmacy education.

#### The Importance of Critical Thinking

A predominant focus of education is to foster the development of learners—to take them from where they are now, to a new level of development. Perry's model of

intellectual development highlights this.<sup>1</sup> Development of CT is ubiquitously endorsed as an important outcome of higher education.<sup>2,3</sup> For cognitive development, higher education can be very helpful.<sup>4</sup> Faculty from diverse university disciplines inherently value CT. More specifically in a meta-analysis of CT in the health professions including pharmacy, CT correlated with academic success.<sup>5</sup> In parallel, pharmacy education's prior Doctor of Pharmacy (PharmD) standards,<sup>6</sup> prior guidelines,<sup>7</sup> and subsequent reports<sup>8</sup> had agreed with the importance of this CT outcome. That said, the most recent CAPE outcomes did not explicitly refer to CT but instead referred to *habits of mind*.<sup>9</sup> As described by Costa and Kallick, habits of mind are a set of behaviors that intelligent people display when confronted with problems that do not have an immediate resolution.<sup>10</sup> In teaching habits of mind, there is interest in the behavior of students when they do not know an answer and how they create knowledge; these sixteen habits of mind are listed in Table 1. Notably, Costa, an early proponent in advancing habits of mind, points out that CT is embedded within the habits of mind, though not specifically mentioned as any distinct single habit.<sup>10,11</sup> In short, habits of mind (including CT) appear to be an important skill set for learners in pharmacy to develop and use.

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**Table 1. A list of the 16 Habits of Mind<sup>10</sup>**

1. Persisting
2. Managing impulsivity
3. Listening with understanding and empathy
4. Thinking flexibly
5. Thinking about thinking (metacognition)
6. Striving for accuracy
7. Questioning and posing problems
8. Applying past knowledge to new situations
9. Thinking and communicating with clarity and precision
10. Gathering data through all senses
11. Creating, imagining, innovating
12. Responding with wonderment and awe
13. Taking responsible risks
14. Finding humor
15. Thinking interdependently
16. Remaining open to continuous learning

### MEASURING CRITICAL THINKING

Any teaching and learning of CT should be measured within learning assessment. Evidence-based pharmacy education<sup>12</sup> relies on measurement of learning data to demonstrate the impact of an intervention on learning outcomes. Using the commonly accepted basis that assessment drives learning,<sup>13,14</sup> we focus on assessment as a key element in the triad of teaching, learning and assessment. For this review, we are taking a backwards-first perspective; a viewpoint suggested in Covey's "Begin with the End in Mind"<sup>15</sup> and Wiggins's "Backwards Design"<sup>16</sup> to assessment. When choosing an instrument for assessment, it is important to keep in mind both the purpose of the assessment and instrument designer's definition of CT. What follows is a description of the various definitions and associated measurement instruments.

#### *Critical Thinking Perspectives and Measurement Instruments.*

While there is general agreement on the importance of CT, different definitions of it exist in the literature.<sup>8,17,18</sup> The CT literature is fractured into different disciplines, and little discussion has taken place to integrate the various models/theories. Likewise, there are many instruments, with each measuring outcomes based on a different definition of CT. A major difficulty in assessing CT is this underlying diversity of definitions; if different measurement instruments were created from different definitions of CT, they are not likely to arrive at a similar answer when used to measure an individual's CT ability. Additionally, multiple scholars have criticized various CT instruments because not all have rigorous psychometric evidence of support.<sup>19-21</sup> While the CT models/theories we describe here have been more comprehensively reviewed previously within pharmacy education,<sup>8</sup> the following is a brief overview. Table 2 summarizes these common tests as well.

The most rigorous<sup>8</sup> model of CT comes from the American

Philosophical Association, where CT was defined as "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based."<sup>22,23</sup> From this conception, the California Critical Thinking Skills Test (CCTST), California Critical Thinking Disposition Inventory (CCTDI), and Health Sciences Reasoning Test (HSRT) were created. A recent meta-analysis of CT in the health professions showed that the CCTST and CCTDI were associated with academic success, though the CCTDI was substantially inferior to the CCTST for this.<sup>5</sup>

From a psychological perspective, Edward Glaser described CT as a cognitive ability with the characteristics of a thoughtful attitude, knowledge of reasoning methods, and skill in application.<sup>24</sup> The Watson-Glaser Critical Thinking Appraisal uses this definition. While it has been used occasionally in the health professions education literature, it has notable concerns with validity.<sup>19</sup> In the previously mentioned meta-analysis, the studies using the Watson-Glaser Critical Thinking Appraisal were mainly conducted prior to year 2000.<sup>5</sup>

Yet another perspective integrates philosophical and cognitive psychology; Richard Paul and Linda Elder define CT as a "mode of thinking - about any subject, content, or problem - in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them."<sup>25</sup> The International Critical Thinking Test was developed from this definition. We are not aware of its use in health education.

Nilson summarizes these various definitions of CT as "involving interpretation or analysis followed by some matter of evaluation or judgment".<sup>18</sup> As noted above, each theory/model has had its measurement instrument. However, adding more confusion to the CT term, other more varied definitions without specific CT measurement instruments are: CT as metacognition<sup>34</sup> (i.e., "thinking about thinking") and CT existing within a developmental framework—whether moral<sup>35,36</sup> or epistemological.<sup>1,26,37</sup> Of note, the issue of various meanings for CT by different educators was a reason why the term "critical thinking" was not used within *either* the original *or* revised Bloom's Taxonomy, while the term "understand" was re-introduced with the revised Taxonomy.<sup>38</sup>

King reminded us that an often-neglected component of CT is moral reasoning.<sup>35</sup> Others have also supported this perspective of CT.<sup>36</sup> The Defining Issues Test (DIT) is a notable assessment of moral reasoning and is also included in Table 2. While qualitatively different as a test, it has a long track-record of research use in higher education.<sup>27,39</sup> The DIT has been used in studies where the working definition of CT was higher-order cognitive-moral thinking. The DIT has demonstrated gains with

Table 2. Notable Critical Thinking Tests

Test	Format/Items	Content	Comments
California Critical Thinking Skills Test (CCTST)	<ul style="list-style-type: none"> <li>Multiple choice, 34 items</li> <li>Self-administered</li> </ul>	<ul style="list-style-type: none"> <li>Evaluates logical thinking and analytical critical thinking skills</li> <li>Each item presents a very brief scenario or statement with specific assumptions of truth</li> <li>Student reflects and judges the conclusion that can best be drawn from their interpretation of the item</li> </ul>	<ul style="list-style-type: none"> <li>From American Philosophical Association consensus definition<sup>22,23</sup></li> <li>Recommended in nursing literature<sup>20,21</sup></li> <li>Correlated most strongly with academic success among health professions in a recent critical thinking meta-analysis<sup>5</sup></li> <li>The CCT-G835 contains more difficult items to test a higher CT ability</li> </ul>
California Critical Thinking Dispositions Inventory (CCTDI)	<ul style="list-style-type: none"> <li>Multiple choice, 75 items</li> <li>Self-administered</li> </ul>	<ul style="list-style-type: none"> <li>Measures the likelihood of students habitually exhibiting the mind-set of an ideal critical thinker</li> </ul>	<ul style="list-style-type: none"> <li>Mapped to definition by American Philosophical Association<sup>23,23</sup></li> <li>Correlated weakly with academic success among health professions in a recent critical thinking meta-analysis and was inferior to the CCTST<sup>5</sup></li> </ul>
Health Sciences Reasoning Test (HSRT) <sup>31</sup>	<ul style="list-style-type: none"> <li>Multiple choice, 33 items</li> <li>Self-administered</li> </ul>	<ul style="list-style-type: none"> <li>Related to CCTST, but uses health sciences scenarios and statements</li> </ul>	<ul style="list-style-type: none"> <li>Mapped to definition by American Philosophical Association<sup>22,23</sup></li> <li>Developed more recently than CCTST</li> </ul>
Watson-Glaser Critical Thinking Appraisal (WGCTA)	<ul style="list-style-type: none"> <li>Multiple choice, 80 items</li> <li>Self-administered</li> <li>Has multiple forms—A, B</li> </ul>	<ul style="list-style-type: none"> <li>Each item presents a statement or paragraph with specific assumptions of truth</li> <li>Student selects the conclusion that can be drawn from the provided item</li> </ul>	<ul style="list-style-type: none"> <li>From Glaser's definition of critical thinking<sup>24</sup></li> <li>More commonly used in the past, mainly in nursing education</li> </ul>
International Critical Thinking Test	<ul style="list-style-type: none"> <li>Written response format</li> <li>Self-administered</li> <li>Not standardized (for individual course instruction with pre-post comparison)</li> </ul>	<ul style="list-style-type: none"> <li>Varied writing prompts (not standardized)</li> <li>Student reads / takes notes on writing sample</li> <li>100-points: <ul style="list-style-type: none"> <li>Part 1 (80-points) – Short answer: 8 items asking student to analyze the writing (10-points each item)</li> <li>Part 2 (20-points) – Essay: student also assesses writing by following test-developer's suggested discussion points</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>From critical thinking definition by Paul &amp; Elder<sup>25</sup></li> <li>Individual instructor chooses the writing sample (from their discipline; not standardized)</li> <li>Measures critical thinking development within a subject or discipline</li> <li>Pre-Post format is designed to influence faculty instruction (not designed for programmatic assessment &amp; comparison to peers elsewhere)</li> <li>Faculty must be trained to grade test</li> </ul>
Collegiate Assessment of Academic Proficiency - Critical Thinking Test	<ul style="list-style-type: none"> <li>Multiple choice, 32 items</li> <li>Self-administered</li> <li>Has multiple forms</li> </ul>	<ul style="list-style-type: none"> <li>Contains 4 passages that each have a series of arguments that support a general conclusion</li> <li>Assesses student's ability to clarify, analyze, evaluate and extend arguments</li> </ul>	<ul style="list-style-type: none"> <li>Reported as "frequently used," but not aware of use in health education</li> </ul>
Collegiate Learning Assessment	<ul style="list-style-type: none"> <li>Multiple choice, 25 items</li> <li>Long-answer (rubric scored)</li> <li>Self-administered</li> <li>Has multiple forms</li> </ul>	<ul style="list-style-type: none"> <li>Involves a performance task (make decision, write report) using series of documents (technical reports, data tables, office memo's, emails)</li> <li>Each document has selected-response questions, then constructed-response report for performance task</li> </ul>	<ul style="list-style-type: none"> <li>Not aware of use in health education</li> <li>Requires rubric scoring for some of test (3 section, 6-point analytic rubric)</li> </ul>
Defining Issues Test (DIT)	<ul style="list-style-type: none"> <li>Multiple choice, 80 items</li> <li>Self-administered</li> </ul>	<ul style="list-style-type: none"> <li>Five scenarios; each presents a different social/ethical dilemma</li> <li>Twelve responses are given for each dilemma; a student judges the degree of importance for each response (5-point scale)</li> <li>As well, a student ranks their four most important responses</li> <li>Student asked to indicate what action they favor by the character in each scenario</li> </ul>	<ul style="list-style-type: none"> <li>Assesses ethical reasoning and cognitive-moral development (which some describe as critical thinking)</li> <li>It is based on Kohlberg's model of moral development<sup>26</sup></li> <li>It is a sensitive indicator of college student achievement,<sup>27</sup> and has demonstrated gains with a "college effect"<sup>28</sup></li> <li>Notably, it is also an indicator for development of a professional<sup>29-31</sup></li> <li>It is very similar to situational judgment tests used in admissions and hiring<sup>32,33</sup></li> </ul>

a ‘college effect.’<sup>28</sup> That is, the DIT score was higher in college graduates than those that did not attend college, was higher in college seniors compared with college freshman, and was higher in students that have had more intense college experiences than others. The DIT has also been aligned with models of intellectual development.<sup>1,31,39</sup> Importantly, the DIT produces some of the most dramatic longitudinal gains when compared to other variables of college student achievement.<sup>27</sup> In a longitudinal study (to be discussed next), the DIT was the single best indicator of cognitive development.<sup>40</sup>

#### *Large Studies of Cognitive Development in Higher Education.*

Overlapping concepts of development and cognitive development have become increasingly foundational within education.<sup>41</sup> To demonstrate development, longitudinal and cross-sectional studies can be used. Longitudinal studies are noteworthy though less frequently done as compared to less time-consuming cross-sectional studies. Use of longitudinal studies with intermittent measurements is more accurate and preferred, though takes much longer with multiple years of data collection.<sup>42</sup> As opposed to weaker cross-sectional studies that compare two different groups of learners to suggest development, a stronger longitudinal design compares each learner to themselves. Over each undergraduate’s 4-year program, one large longitudinal investigation of 2300 students studying a variety of majors at four-year higher-education institutions used the Collegiate Learning Assessment.<sup>2</sup> Meanwhile another multi-year longitudinal investigation of 2212 undergraduate students studying a variety of majors in liberal arts colleges used the Collegiate Assessment of Academic Proficiency - Critical Thinking Test and DIT.<sup>40</sup> Neither study reported substantial development for analytical CT, while the DIT showed a noted improvement.<sup>39</sup> We are not aware that either the Collegiate Learning Assessment or Collegiate Assessment of Academic Proficiency - Critical Thinking Test have been used in health professional education programs (though are included in Table 2). While developing CT appears to be an important outcome of higher education (and so is being repeatedly investigated), these large multi-institutional investigations that studied cognitive development used different CT instruments.<sup>2,40</sup> The lack of any definitive analytical CT assessment used in these large investigations further underscores the diversity of definitions and variety of CT instruments.

#### **BUT WHAT IS CRITICAL THINKING?**

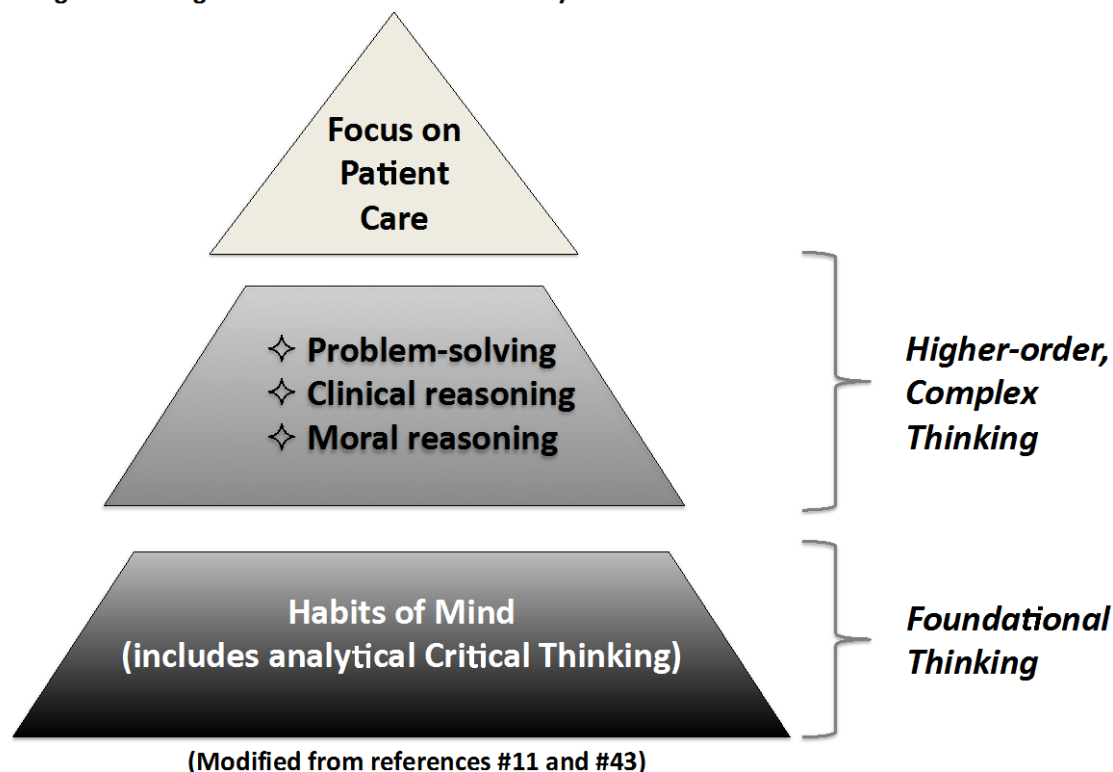
*A Model of Critical Thinking.* Developed over a decade ago by Marzano et al, the Dimensions of Learning model gives a framework for thinking of CT as part of foundational habits of mind.<sup>11,43</sup> In this framework, habits of mind is one dimension, while complex thinking is another dimension; habits of mind are a needed cognitive ability for complex thinking. Similar to the laudable Bloom’s Taxonomy and Miller’s Pyramid, we recast this framework into a familiar pyramid format in Figure 1;

habits of mind provide a foundation on which later complex thinking can build. The Dimensions of Learning framework illustrates the foundational role of critical thinking, along with the roles of complex problem-solving and reasoning. Foundational thinking includes habits of mind and the often used (and sometimes misused) “critical thinking.” Importantly, this foundational CT provides a solid basis for good complex thinking, such as problem-solving and clinical reasoning. Recent 2016 PharmD Standards continue to highlight that problem-solving and clinical reasoning skills are key elements needing assessment of PharmD students.<sup>44</sup>

As noted previously, habits of mind are a set of 16 intelligent behaviors that should be cultivated throughout education—from kindergarten into higher education and beyond (Table 1). Pursuant to pharmacy education, these *habits of mind* are noted in the 2013 CAPE Outcomes.<sup>9</sup> Therein, CT is not explicitly stated as one distinct habit, but it is integrated within these habits.<sup>10,11</sup> The Dimensions of Learning model provides a noteworthy framework of learners’ cognition.<sup>11,43</sup> This framework represents a unique contribution to and extension of CT, habits of mind and clinical reasoning dialogue in pharmacy. Based on this framework, Figure 1 illustrates a progression of cognitive skills. CT is a *rudimentary* skill that needs initial development, and helps provide a robust basis for the complexities of problem-solving, clinical reasoning or moral reasoning. In short, developing complex thinking should be at the core of professional programs, and CT will help provide a foundation for better complex thinking.

*More on Measuring Critical Thinking.* Figure 1 suggests that CT is a generic, foundational habit of mind, and so a test like the CCTST could be used to measure this foundational CT. Of CT tests, validity evidence for the CCTST appears strong.<sup>8,19-21</sup> Developing habits of mind early in education should help students with their later complex studies. The CCT-G835 is very similar to the CCTST, though made with some more difficult items to test a higher CT ability than the CCTST; it may have greater promise in selective professional programs, such as pharmacy. In general, PharmD students in the United States tend to score very well on the CCTST (Dee August, senior psychometrician at Insight Assessment, email communication May 2014). Thus, pharmacy students are often clustered as “strong” or “superior” critical thinkers. With statistical discrimination for the CCTST measuring from weak CT to strong CT, much of the instrument’s scoring range will not be used to measure most pharmacy students’ abilities. Psychometrically, to measure an ability and to show a meaningful difference the testing instrument must become even more challenging (by moving the scoring “ruler” towards more difficult); the CCT-G835 does this, and may be more appropriate for CT measurement in pharmacy education—though more research is needed on this.

Figure 1. A Cognitive Framework for Pharmacy Education



*More on Measuring Complex Thinking.* Meanwhile, cognitive-moral development (complex thinking that some educators may classify as CT) appears better assessed with an instrument like the DIT. While the DIT only measures one aspect of complex (i.e., higher-order) thinking, this thinking can be more challenging to assess. Moving from foundational to complex thinking, context specificity becomes a much larger concern. Problem-solving,<sup>45</sup> clinical reasoning,<sup>46</sup> and moral reasoning<sup>26,39</sup> have multiple dimensions; assessment of complex thinking will need *cases and multiple questions with different case contexts* (ex. cardiology, pulmonary, oncology, end-of-life care) as well as recognizing that often more than one “correct” answer exists, with better answers not being just memorized facts of logic but depending more on each case’s situational context. Situational judgment tests are an application of complex thinking assessment focused towards professional program admissions and hiring;<sup>32,33</sup> they are very similar to the DIT.

#### Evidence of Cognitive Development within Pharmacy Education

In this issue of the Journal, we also report a meta-analysis focused on CT development specifically in pharmacy education.<sup>47</sup> In this summary of longitudinal studies of

pharmacy students, we found that the CCTST and DIT showed promising *responsiveness to change*<sup>48</sup> (i.e., scores on repeated attempts by a student would improve following exposure to a PharmD curriculum). We did not find any studies of CT development in pharmacy education that used the HSRT. While the CCTST and DIT measure “critical thinking”, they clearly measure different aspects of thinking. Reviewing hardcopies of these tests, it was apparent that the CCTST should measure analytical CT, while the DIT should measure ethical reasoning (i.e., a type of higher-order thinking). However, the DIT also appears to be an indirect barometer of other cognitive development—and has been referred to as measuring cognitive-moral development. Importantly, the DIT has also been associated with development of a professional. It has been recommended to measure medical professionalism<sup>29</sup> and pharmacy professionalism, as well.<sup>30</sup> This framework has correlated with improved appropriate/ethical action by clinicians,<sup>31</sup> and developing professional pharmacists is an important outcome sought by the Accreditation Council for Pharmacy Education; its measurement and assessment are needed.<sup>44</sup> Beyond moral reasoning, the DIT measures higher-order, cognitive development.



## PHARMACY EDUCATION IMPLICATIONS AND APPLICATIONS

### Critical Thinking

Unfortunately, broad studies of cognitive development among undergraduates from research universities, liberal arts colleges, Historically Black Colleges and Universities, and Hispanic Serving Institutions have repeatedly shown limited analytical CT gains.<sup>2,39</sup> Just because educators think they are teaching CT, does not mean that they actually are. As opposed to complex thinking (using the DIT), higher education's outcome of CT development does not appear to be widely met. In a retrospective audit of CT practices among college courses, investigators looked at course syllabi and materials to assess whether CT was likely being taught.<sup>48</sup> Investigators determined that CT did not appear to be taught in the vast majority of courses that suggest that it is taught within, even though course instructors (with their expertise in other areas aside from cognitive psychology and CT) stated in course syllabi that it was taught. However in the minority of courses when it is taught, CT appeared to *only* be taught in courses with *deliberate, explicit instruction* of the CT process. We should not expect pharmacy educators to be different from other faculty; pharmacy educators often have expertise in pharmacy-related content though informal training in pedagogical principles, such as teaching CT. In this journal issue, the associated meta-analysis of the CCTST in pharmacy education showed some inconsistent improvement, with half of studies not showing any difference, while others did show (often minimal) improvement.<sup>47</sup>

*Implications.* As noted earlier, pharmacy students in the United States very often demonstrate strong to superior CT ability. Applying the commonplace law of diminishing returns, it would take much time and effort to develop students with strong CT into superior CT (i.e., a small gain in something pharmacy students are already strong within); meanwhile, pharmacy students may have more potential for substantial growth with less educational time and effort by focusing instead on important complex thinking skills that students are weaker within, such as problem-solving, ethical reasoning, and clinical reasoning. Teaching and learning CT within pharmacy programs may not be a judicious use of a college/school of pharmacy's educational resources, such as faculty time, effort and finances. This is not to say that CT is not important, but just that CT may better be selected for instead of actively, deliberately instructed to all pharmacy students.

*Application of CT to Pharmacy Admissions.* Numerous studies have used the Pharmacy College Admissions Test (PCAT) to identify candidates that will be academically successful in pharmacy programs.<sup>50</sup> As a result, many colleges/schools of pharmacy use the PCAT as part of their admissions criteria. In multiple studies, the PCAT has also been associated with CT as measured by the CCTST.<sup>51,52</sup> In one investigation that used the PCAT and HSRT (a CCTST variant) for admission, the HSRT

appeared redundant to PCAT for admission data; the PCAT appeared to adequately measure CT within admissions.<sup>53</sup> However, investigators in another program suggested that while correlated, it seemed to add new information, though did not expand on any utility for this new information.<sup>54</sup> With either study results, it would seem advantageous, compared to any small information gains, to change focus towards *non-cognitive* assessments, such as building a much more reliable interview process.<sup>55-57</sup> This non-cognitive assessment approach is aligned with the 'holistic admissions' movement,<sup>58</sup> as well as at least the last two versions of PharmD standards.<sup>6,44</sup>

### Higher-order, Complex Thinking

In agreement with other pharmacy education leaders, the DIT appears to be one sound indicator of growth in complex thinking over the course of PharmD education.<sup>29,59,60</sup> Evidence suggests that students' reasoning will not appreciably develop without instruction; the complex thinking of reasoning<sup>9,61</sup> and problem-solving<sup>44,62</sup> *do* need to be cultivated within each PharmD program. It is important to note that complex thinking skills are context-specific; they are not one generic skill with one general process. *Context specificity*<sup>63,64</sup> needs to be considered when assessing these complex thinking skills throughout pharmacy education.<sup>65,66</sup> Similar to teaching CT, pharmacy educators need to focus on complex thinking skills through deliberate integration of problem-solving and reasoning into their coursework. Of note, the 2016 PharmD Standards highlight teaching, learning and assessment of higher-order thinking skills, such as problem-solving and reasoning.<sup>44</sup>

### SPECIFIC RECOMMENDATIONS FOR MOVING FORWARD

Seeing CT as a foundational dimension of thinking for PharmD students, and focusing instruction on complex thinking requires pharmacy educators to change more than terminology—it should be a clarification of this entire concept. Based on our review of the literature, we would suggest that:

- A. Pharmacy programs should periodically use the DIT to assess cognitive development of students in their program. Development is an ethos of education—helping students to grow in their cognitive abilities—and should be an imperative for programs. Complex thinking should be assessed and monitored for improvement. As well, the DIT is a measure of professionalism,<sup>29,30</sup> and development of professionalism is a key component to foster in PharmD graduates.<sup>44</sup> Like a patient's pulse, the DIT should be re-assessed periodically to make sure this vital sign remains positive.
- B. Pharmacy programs should forego using the CCTST or HSRT. While CT has been associated with academic success, many current pharmacy admission criteria appear to already consider this ability adequately.

College/school of pharmacy resources, such as faculty time, energy and finances may better be spent developing students' complex thinking and professionalism, than trying to improve pharmacy students' already-strong CT further.

- C. Pursuant to the 2016 PharmD Standards, all educators in a PharmD curriculum should *deliberately* design their coursework to stimulate higher-order thinking such as problem-solving and clinical reasoning. Similar to CT,<sup>48</sup> faculty educators will not likely teach complex thinking unless they deliberately focus on it.

## CONCLUSION

While critical thinking is recognized as an important outcome in pharmacy education, the assessment of CT development in learners is complicated by its multiple definitions and the variety of assessment instruments that have been developed based on those definitions. The CCTST is an instrument that measures foundational CT. Pharmacy admissions is a notable implication, though the PCAT appears to serve as an adequate assessment of foundational CT before students enter a PharmD program. Throughout any PharmD program, increasing students' reasoning and problem-solving skills should be a goal, along with their professional development. The DIT measures complex thinking and is effective in assessing the longitudinal development of cognitive-moral reasoning in college students. Germane to PharmD programs, the DIT also measures professional development. Assessing cognitive abilities requires thoughtful use of measurement instruments, and this presented framework should help provide clarity.

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