

## **An Environmental Scan on the Status of Critical Thinking and Problem Solving Skills in Colleges/ Schools of Pharmacy: Report of the 2009-2010 Academic Affairs Standing Committee**

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According to the Bylaws of the American Association of Colleges of Pharmacy (AACP), the Academic Affairs Committee shall consider

*the intellectual, social, and personal aspects of pharmaceutical education. It is expected to identify practices, procedures, and guidelines that will aid faculties in developing students to their maximum potential. It will also be concerned with curriculum analysis, development, and evaluation beginning with the pre-professional level and extending through professional and graduate education. The Committee shall seek to identify issues and problems affecting the administrative and financial aspects of member institutions. The Academic Affairs Committee shall extend its attention beyond intra-institutional matters of colleges of pharmacy to include interdisciplinary concerns with the communities of higher education and especially with those elements concerned with health education.*

Consistent with a theme of exploring the way in which AACP might foster organizational improvement and success among its institutional members, President Jeffrey Baldwin charged the 2009-10 AACP Academic Affairs Standing Committee to consider the outcomes of the 2009 AACP Curricular Change Summit and the recommendations contained in the 5 background white papers.<sup>1-5</sup> The Committee was charged to synthesize recommendations for AACP and its member institutions with regard to curricular issues that need further development, study or implementation.

The Committee reviewed and discussed some of the key outcomes from the AACP Curricular Change Summit. Summit participants were asked to identify the 1 or 2 key outcomes that each graduate should possess upon graduation. The Summit participants concluded that the most essential components were critical thinking and problem solving skills. Another of the major findings from the September 2009 AACP Curricular Change Summit was that the generation of students currently entering undergraduate education and trickling into colleges/schools of pharmacy learn differently from previous student cohorts.

Summit participants suggested that it is not as much what is being taught that is the issue with this generation of learners, but rather the manner in which it is taught; specifically the way critical thinking and problem solving skills are learned.

### **The Changing Learner**

The ability to educate students is an increasingly complicated task that is impacted by a number of factors including the changing learner. It has become apparent that today's students communicate and may even learn in ways unlike previous generations.<sup>6</sup> These students are more comfortable with technology, having used computers, played videogames, and utilized other interactive technologies throughout most of their lives. They are more adept than previous generations at multi-tasking with media and technology; they listen to music, talk or text and use the computer simultaneously.<sup>7</sup> Some categorize these students as the Net generation, while others refer to them as the Millennial generation.<sup>8</sup> This group, typically born between 1982 and 1991, is the first generation to be raised with Internet availability.<sup>8</sup> Prensky refers to these learners as digital natives, as they are "native speakers" of the digital language of computers and the Internet.<sup>7</sup> Computers, the Internet, online resources, and the desire for instantaneous access are fundamental to these students' lives.<sup>8</sup> They are constantly connected and in communication with others through the use of email, social network sites, instant messages (IM), and text messages.<sup>9</sup>

Socialization is very important to this new generation of learners. They are especially attracted to activities that include interaction with their peer group.<sup>6</sup> They like to learn and work in teams, however, their interaction need not be face-to-face. For them, technologies such as email, blogs, and online social networking sites can be just as effective as face-to-face interaction.<sup>8</sup> Despite the fact that this generation frequently uses technology, they want their learning to include more than just technology. They value their teachers' knowledge and expertise and want to have the opportunity to communicate with faculty when assistance is needed.<sup>6</sup>

This new generation of learners has less tolerance for passive instruction and prefer to learn by doing.<sup>9</sup> Just as they rarely read newspapers, they also tend not to read lengthy instructions or assignments.<sup>8</sup> They like learning environments that are rich in multimedia, especially those that are visual and/or audio in nature. Those individuals raised in an environment with ready access to computers

have less linear thought processes and struggle with traditional approaches that are substantially more linear. These students prefer random access.<sup>7</sup>

These new learners are achievement oriented.<sup>8,10</sup> They prefer structure and want clear learning outcomes.<sup>8</sup> They seem to work well under pressure<sup>11</sup> and flourish with immediate gratification and frequent rewards.<sup>7</sup>

What we are currently experiencing in higher education with these new learners is just the tip of the iceberg. A 2009 study by the Kaiser Family Foundation surveyed over 2,000 young people between the ages of 8 and 18 years and reported that this population spends on average approximately 7.6 hours each day using media. This represents an increase from 6.5 hours in a similar survey conducted in 2005. On a typical day, an average 8- to 18-year-old spends approximately three hours evenly divided between playing video games and other recreational computer use. Compare this to the average amount of computer time daily (16 minutes) devoted to homework. Comparison of the 2009 survey results with those from the 2005 study shows an increase in overall time that young people spend using more than one media at a time (29% versus 26%).<sup>12</sup> It is interesting to note that heavy media users were more likely to earn fair or poor grades (respondent self-identified categorization: 47% heavy users, 31% moderate users, 23% light users), to be bored, to get into trouble, or to be often sad or unhappy, and are less likely to get along with their parents.<sup>12</sup> Another important change is the increase in access to and use of computers and the Internet. The number of young people with computers in the home increased from 86% in 2005 to 93% in 2009, and access to the Internet in the home increased from 74% to 84% during this five-year period.<sup>12</sup>

The extensive exposure of the millennial generation to video games led to a movement toward incorporation of video games in education and training.<sup>13</sup> PriceWaterhouseCoopers estimates that the global video game market will grow to \$48.9 billion in 2011 and that many corporations use games to recruit and train employees from the digital native workforce.<sup>9,14</sup> Oblinger suggests that games have attributes associated with learning including problem solving and the use of research skills (e.g., testing hypotheses).<sup>8,15</sup>

Given the unique characteristics of the changing learner, what are the implications for pharmacy educators? There are at least 4 key suggestions to consider: 1) lectures may not provide an optimal

learning environment.<sup>8,9</sup> This generation has different expectations of faculty and the delivery of course content. The teacher needs to become a facilitator of learning and less of a provider of information.<sup>6</sup> 2) The relevance of assignments must be transparent to the learner. These students detest busy work.<sup>16</sup> 3) Interaction should be an important component of the educational process, as these students value group work and collaborative learning.<sup>6,9</sup> 4) The new generation of learner appreciates faculty who respond quickly, provide constructive feedback, and are familiar with and effectively use digital tools in the classroom.<sup>17</sup>

The characteristics of the changing learner have curricular implications as it relates to the structure, as well as the methods used in both the pre-professional and professional curricula. The purpose of this Report was to provide an environmental scan on the curricular considerations associated with both critical thinking and problem solving. While this is certainly not a new skill set, it behooves us to re-evaluate the methods and tools that we use going forward for skill development and application given the characteristics of the changing learner.

### **Critical Thinking and Problem Solving**

The AACP Commission to Implement Change in Pharmaceutical Education identified six general outcomes/competencies that serve as the foundation of the education of a professional. The ability to think, including logical thinking, analytical thinking, problem solving and decision making, was identified as an important outcome for pharmacy education.<sup>18</sup> The use of critical thinking, identified by the commission as a competency of the thinking ability outcome, is assumed to result in pharmacy practitioners that are better able to solve problems and think as experts.<sup>19</sup> In describing their rationale, the commission stated:

Entry-level graduates must be able to examine issues rationally, logically and coherently. Although critical thinking is a universally desired educational outcome, professionals particularly need a repertoire of thinking strategies that will enable them to acquire, evaluate and synthesize information and knowledge. Since much of professional practice is problem solving, students need to develop analytical skills to make decisions in both familiar and unfamiliar circumstances. Critical thinking fosters a questioning attitude among professionals; and it is a prerequisite skill in making judgments.<sup>18</sup>

Critical thinking and problem solving, as indicated above, are often mentioned together. However, multiple authors have expressed the relationship between critical thinking and problem solving in different ways. Some authors state that critical thinking encompasses problem solving.<sup>20,21</sup> Others suggest that

problem solving may be one of the purposes for which we engage in critical thinking.<sup>22</sup> Taking this purpose to another level of specificity, some authors suggest that while problem solving is an often performed action, it may not always be performed by thinking in a critical manner.<sup>23</sup> Based on the work of the AACP Commission to Implement Change in Pharmaceutical Education, this final view appears to be most applicable to goals in pharmacy education.

While it is important to consider that critical thinking and problem solving are linked, situations arise where one skill may exist separately from the other. Individuals may engage in critical thinking, but not use the resulting thought to solve a problem. Thus, consideration of these terms separately is warranted in order to proceed with instructional design and assessment. Thus, a clear operational definition of each is required.<sup>24</sup>

### Critical thinking debates

The definition of critical thinking has opened the door to multiple debates of the term. The broadest debate among both experts and popular culture involves the separation of critical thinking from good thinking. Critical thinking may be assumed to be good thinking that solves problems, which is the opposite of illogical or irrational thinking that is more likely to cause problems.<sup>23</sup> The majority of experts agree that critical thinking is not the only kind of good thinking. Broad in scope, good thinking may include creative or innovative thinking. Creative or innovative thinking results in new insights, novel approaches, fresh perspectives, and whole new ways of understanding and conceiving concepts or processes. Experts have concluded that what critical thinking means, why it is of value, and ethics of its use are 3 separate concerns.<sup>25</sup>

Three debates exist with regard to the definition of critical thinking as it relates to teaching strategies. The first debate centers on the view that critical thinking is either a general skill set that spans disciplines or is a specific skill set that varies across disciplines. Most experts suggest that general principles apply across disciplines and support learning critical thinking skills in concert with specific subject matter. The second debate addresses the exclusion of evidence such as experience, emotion, feeling, care and commitment in definitions of critical thinking. It is suggested that relativism may be stimulated by focusing only on valid arguments developed through rational and logical reasoning. Experts argue that dispositions related to critical thinking must balance reason.<sup>26</sup> This is an especially important debate for

health care professionals because critical thinking is often employed in the care of individual patients.

The final debate considers the degree to which social context is a part of critical thinking. Experts make a case that the political and social justice impacts of argumentation and reasoning should be considered in teaching critical thinking.<sup>26</sup>

### Critical thinking defined

The American Philosophical Association (APA), through an expert consensus statement, supports the value of critical thinking by stating, “Critical thinking is essential as a tool of inquiry. As such, critical thinking is a liberating force in education and a powerful resource in one’s personal and civic life.”<sup>25</sup> Such emphasis can lead to ambiguity and the proliferation of a variety of definitions. Multiple articles in the pharmacy education literature have articulated the wide variety of definitions of critical thinking.<sup>19,27-29</sup> Despite the diversity there are clear trends that are identifiable in the definitions.<sup>19,27-29</sup> In Table 1 there are a variety of critical thinking definitions that speak to the different sides of the previously mentioned debates. It should be noted that the most rigorously defined version of critical thinking comes from the APA Expert Consensus Statement for Purposes of Educational Assessment and Instruction.<sup>25</sup> The definitions in Table 1 support Halpern’s claim that there is enough overlap in the definitions of critical thinking to take the next steps in preparing learners to think critically.<sup>24</sup> Because the definitions consist of similar skills, actions, and dispositions, a reasonable next step is to extrapolate and explain these skills and dispositions. It is important in this step to describe examples from pharmacy that help to identify when and where these skills and dispositions can be assessed. Table 2 summarizes the skills associated with critical thinking that have been identified by the APA, associated definitions and selected pharmacy examples. Table 3 summarizes those dispositions mentioned by the APA that encompass approaches to life and living as well as specific issues, questions or problems.

### Problem solving defined

Problem solving is considered a high-order thinking skill that represents the ability achieved by mastery of each level of Bloom’s taxonomy.<sup>37</sup> Though problem solving is a high-order thinking skill with a close connection to critical thinking, it has a definition distinct from critical thinking. While also a highly debated topic, most debate related to problem solving revolves around the techniques and methods of problem solving rather than the definition. Problem solving can be broadly defined as the process of

designing, evaluating and implementing a strategy to answer an open-ended question or achieve a desired goal.<sup>38</sup>

The Association of American Colleges and Universities (AAC&U) VALUE (Valid Assessment of Learning in Undergraduate Education) program was an attempt to create and disseminate rubrics to assess learning through the measurement of outcomes.<sup>36,38</sup> The rubrics delineate expected criteria and information to determine individual standards to match growth. The Critical Thinking VALUE Rubric and Problem Solving VALUE Rubric are excellent instruments that can be molded to meet the needs of pharmacy education. Defining the expectation of mastery of each area at benchmark, milestone, and capstone levels allows the evaluator to measure student attainment. The fact that separate rubrics were developed to allow for independent measurement of these skills provides ample support for separate consideration of these terms.

The Critical Thinking VALUE rubric<sup>36</sup> provides the expectation that mastery of critical thinking includes explanation of an issue, selection and use of evidence to investigate a point of view or a drawn conclusion, the influence of context and assumptions, the position on the issue taken by the student/learner, and the conclusions drawn by the student/learner. The Problem Solving VALUE rubric<sup>38</sup> provides the expectation that mastery of problem solving includes definition of the problem, identification of strategies to solve the problem, solutions or hypotheses proposed, evaluation of potential solutions, solution implementation, and outcome evaluation.

Implementation of these rubrics requires evaluator training and education of the student/learner. The evaluator must understand expectations and terms and be able to use them to “rank” the student/learner’s performance. The student/learner should be exposed to the rubric to gain an understanding of the expectations for mastery at each level.

If the academy faculty agree that critical thinking and problem solving skills are fundamental to the successful practice of pharmacy and that our graduates should achieve an appropriate level of competency prior to graduation, then every effort should be made to establish consistent goals and definitions related to this skill set. Though not the focus of this Report, faculty development opportunities should be available to establish and/or supplement the faculties’ ability to teach and apply principles of critical thinking and problem solving.

**Recommendation 1:** Pharmacy education should support the development and use of clear and distinct definitions for critical thinking and problem solving to guide instructional development and assessment of each.

**Suggestion 1:** Colleges/schools of pharmacy must recognize critical thinking as a general skill set that can be further developed for use in the practice of pharmacy through instruction and assessment within the professional pharmacy curriculum.

**Suggestion 2:** Colleges/schools of pharmacy must link learning experiences to specific critical thinking skills that can be assessed.

**Suggestion 3:** Colleges/schools of pharmacy must foster critical thinking skills in all areas of a student's present and future life, including, but not limited to clinical issues specific to pharmacy.

### **Curricular Considerations**

Accreditation Council for Pharmacy Education (ACPE) Standards and Guidelines 2007 require that colleges and schools of pharmacy ensure that graduates possess critical thinking and problem solving skills.<sup>39</sup> Although the Standards and Guidelines go on to describe that the development of these skills should be supported through the application of computerized and other instructional technologies, laboratory experiences, and experiential education, ACPE does not provide reasons for this requirement nor do they provide specific examples of the way in which this outcome should be achieved and demonstrated.

As noted elsewhere in this report, we believe that this requirement is in place, in part, because all health care professionals (e.g., pharmacists, physicians, nurses, dentists) need to make numerous decisions that affect patient care on a daily basis. Frequently, the information needed to make a therapeutic decision is incomplete and therefore requires the health care professional to look beyond established data to identify a course of action. The ability to evaluate the data available, identify missing information, think outside established norms, contemplate logical scenarios should different strategies be implemented, and deal with inferences, may be termed critical thinking.

As just a couple of the many components of the practice of pharmacy, patient safety and treatment effectiveness, should certainly be a significant component of the rationale for teaching and developing critical thinking skills in student pharmacists. Pharmacists must instinctively and consistently question prescribers to ensure reconciliation of medications across the continuum of care. Similarly, discharged patients and/or caregivers must be knowledgeable of the therapy plan, including the role of the

pharmacist. It is the pharmacist that will evaluate relevant cultural, educational and cognitive traits and their impact on development of a learning plan for a specific patient.

It is certainly a challenge to teach critical thinking<sup>23</sup> or to enhance a student's ability to think critically, nevertheless we do so in a variety of ways across pharmacy and other health care profession curricula. Table 4 provides some examples of the ways that this issue has been addressed by colleges/schools of pharmacy. Even a cursory review of these (and other) references suggests that little has been published on teaching critical thinking throughout the curriculum. It is difficult to know whether this is simply an indication that little has actually been published or a reflection of the fact that few institutions ensure that critical thinking (and perhaps problem solving) is a component of the professional curriculum.

One issue that faces colleges/schools of pharmacy is how and when development of critical thinking and problem solving skills should start from a curricular perspective. Should this be a component of the pre-pharmacy curriculum or limited to the entry-level PharmD curriculum? Should this skill set be addressed in a specific course or two in the professional curriculum or does this skill set need to be disseminated across the curriculum – similar to the way in which experiential education is distributed? Both approaches have been addressed to some extent in the literature, however, it appears to the Committee that the latter approach is optimal to ensure that today's student pharmacist develops the critical thinking skills needed to be a successful professional.

**Suggestion 4:** Colleges/schools of pharmacy should ensure that the development of critical thinking skills becomes the backbone of the curriculum, and that courses throughout the curriculum are designed specifically to provide students with the opportunity to obtain and use these skills, that the skills are assessed appropriately, and that the attainment of these skills are documented before the student is permitted to graduate. Assessment of this skill should be a formal component of preceptor evaluation of P4 students.

**Recommendation 2:** AACP should issue a call for school posters to be presented at the AACP Annual Meeting that describe the methods by which critical thinking is taught and/or evaluated in the didactic and experiential curricula at colleges/schools of pharmacy.

**Recommendation 3:** AACP should issue a call for submissions to Pharmacy Education Assessment Services (PEAS) for assessment methodologies including rubrics that are used by colleges and schools of pharmacy to assess the critical thinking and problem solving skills of their students.

**Recommendation 4:** AACP should plan an Institute that provides hands-on application of evidence-based active learning strategies for the new generation of learners. (prior to final publication of this report this recommendation was accomplished at the May 2010 AACP Institute in Lansdowne, Virginia.)

### When to teach critical thinking and problem solving skills

As mentioned in the previous section, the first question to reflect on is whether critical thinking skills must be taught by content area or if they can be taught as a skill set that can be transferred across multiple disciplines. In other words, can these skills be taught in general pre-pharmacy courses or should this type of development be delayed until students are enrolled in professional program courses that are specifically focused on pharmacy topics? In cognitive psychology, there is support for the idea that an explicit effort to teach critical thinking skills that are transferable across several disciplines can be successful. If the value of this skill set across disciplines is not made obvious, then it is likely that the learner will limit his/her skill development to the course(s) in which it is used.<sup>43</sup> This supports the idea of development of critical thinking and problem solving skills in pre-pharmacy curricula, although the variation among pre-pharmacy curricula is notable. The second question to consider is how to influence students to apply critical thinking once they have the skills. The students' disposition toward critical thinking includes their ability to recognize when that skill is needed, as well as their willingness to put forth the effort to use it. It may be easiest to influence students to apply those skills while enrolled in the professional program when the relevance of applying these skills to patient care-based issues is the most obvious. In order to facilitate teaching critical thinking skills, Halpern proposes a four-part instructional model: skill instruction, disposition development, problem recognition, and observation of the process used in critical thinking (metacognitive monitoring).<sup>43</sup>

### Assessment of critical thinking and problem solving skills of incoming students

If the development of critical thinking and problem solving skills occurred as an element of the pre-pharmacy curriculum, then assessment of these skills as a component of an admissions application may assist colleges/schools to predict candidate success in the professional program. Over the past several decades, studies were conducted to determine whether pre-pharmacy or admissions variables could predict which students would succeed in a professional pharmacy program. The focus of most of these studies was on "success" in pharmacy programs, with grade point average (GPA) used as the measurement of success.<sup>44-54</sup> It is of note that critical thinking and problem solving skills were not specifically addressed in these studies or considered as a specific measure of success.

Many studies found positive associations between success in a pharmacy program and prior completion of a four-year degree, but none looked closely at the characteristics of applicants with four-year degrees to determine the extent to which factors such as age, motivation, or intellectual ability contributed to the students' completion of the degree and subsequent performance in a professional program.

One study by Cline *et al.* did shift the focus to success in practice (and not academic program) and used 4 predictors of success not utilized in other studies: career commitment, innovativeness, materialism, and other-directedness.<sup>55</sup> The innovativeness dimension of practice success included measures of willingness to adopt new ideas and included how a person would be inclined to bring new ideas to problem solving efforts.<sup>55</sup>

Other studies included an explicit measure of critical thinking skills. Allen and Bond found a link between performance on the California Critical Thinking Skills Test (CCTST) and subsequent performance in practice-based courses.<sup>56</sup> In this study, the Pharmacy College Admission Test (PCAT) was also a good predictor of performance.<sup>56</sup> Kidd and Latif later found the CCTST and not the PCAT to be a predictor of performance in advanced pharmacy practice experiences (APPEs). A second measure of critical thinking, the California Critical Thinking Disposition Inventory (CCTDI), was a predictor of success in earlier coursework.<sup>57</sup> Lobb and colleagues looked at the results from the Learning and Study Strategies Inventory (LASSI), Defining Issues Test (DIT), and Watson-Glaser Critical Thinking Appraisal (WGCTA) as predictors, however, found no correlation with subsequent academic performance.<sup>58</sup> In all of these studies, the subsequent academic success was measured by grades and not critical thinking *per se*.

Not directly studied was the impact of age on critical thinking and problem solving skills. Non-Piagetian theorists suggest that there is a fifth stage of cognitive development that occurs in young adults; this fifth stage is called post formal thinking and it focuses on problem finding. At this stage of development, the young adult begins to identify the problem before him/her and determines ways to solve it even if faced with contradictory information and awareness of the relativistic nature of their knowledge.<sup>59</sup> Given the age of a typical student pharmacist, it is certainly possible that this last stage of cognitive

development may still be “percolating” and that assessment of this skill set may reflect, at least in part, the extent to which this stage has matured.

### **Teaching critical thinking and problem solving skills in the professional curriculum**

Once enrolled in the professional program, students participate in both didactic and experiential learning experiences. There are specific instructional methods considered effective in the development of critical thinking and problem solving skills. These methods tend to be learner-focused, inquiry-based learning approaches that employ reflective methods, writing to learn, and paired or group processes. Regardless of whether the method focuses on discipline-specific or general critical thinking and problem solving skills, it is important to employ good instructional design. Two recommended resources are Chickering’s “How People Learn” and Gamson’s “Seven Principles of Good Practice,” both of which were listed in the Curriculum Summit white paper by Jungnickel et al.<sup>3</sup>

A key to success in the development of this skill set is to incorporate those active learning instructional methods into both the classroom and experiential settings that are known to develop critical thinking including, inquiry-based learning, working with others, and writing to promote reflective thinking.<sup>3</sup> As expected, an effort should be made to explicitly teach and then assess critical thinking and problem solving skills. Several instructional approaches used to promote the development of critical thinking and problem solving skills are described in the following sections.

#### Inquiry-based learning

Inquiry-based learning revolves around the learner and what he/she already knows and needs to find out in order to complete a task such as solving a problem, case review, answering a complex query, or preparation of a care plan. The use of questions by the instructor as well as the student is a key part of this method. Students should learn through a discovery process where they ask the questions and seek the answers. Instead of providing answers, the teacher serves as a guide or facilitator for the process. Through the question and answer process, students should develop new knowledge while applying critical thinking and problem solving skills.<sup>3</sup>

One form of inquiry-based learning that is used in pharmacy programs is problem-based learning (PBL). This approach to inquiry-based learning focuses the learner on a problem that needs to be resolved. It involves presentation of a problem followed by group discussion to identify what is known,

what is unknown, as well as to formulate hypotheses. Group members then conduct research on their portion of the investigation and bring findings back to the group to review and reach a solution. For example, students may be given the task of designing a pharmacy service or a new pharmaceutical agent.<sup>60</sup>

Another inquiry-based approach frequently seen in pharmacy programs is case-based learning. This differs from problem-based learning in that it focuses on building knowledge and resolution of problems that may not have a clear-cut answer. Ethical dilemmas and patient-specific cases are often used in a case-based approach. Many of the methods used in problem-based learning such as group discussion and independent research are also viable in case-based learning. Examples of inquiry-based learning methods used in pharmacy programs are listed in Table 5.

#### Team or group learning

Another type of instructional method designed to promote critical thinking and problem solving skills is team or group learning; this is often paired with an inquiry-based learning experience. This approach includes discussion and communication among group members, a valuable tool in the development of critical thinking skills. Because group or team learning assumes all students in the group have team skills, it is important to ensure that they do. As a result, in addition to explicit efforts to develop critical thinking and problem solving skills, the instructor should also promote the development of communication and team or group skills.<sup>42,62</sup>

#### Writing to learn and reflect

Writing is often overlooked as a tool for learning. While the development of formal writing skills is essential, the development of informal writing skills that can be used to facilitate concept mastery and reflection is also important. In the development of critical thinking skills, informal writing exercises can help the student identify and organize issues and ideas, uncover missing information, and find misconceptions or faulty reasoning. Such writing is not graded for its literary value, but rather for its demonstration of thoughtfulness and idea development. Writing to learn may be accomplished in a variety of formats including journals, one-minute papers, as well as wikis and blogs.<sup>29,61</sup>

### Technology-based tools

As mentioned earlier, technology alone does not ensure a good learning experience. As with other methods, it must be used in conjunction with good instructional design. That said, technology is thought to promote critical thinking and problem solving skill development in a support role. Specifically, technology facilitates the ability to provide immediate feedback; it promotes communication of ideas, serves as an aid in reflection, and enhances access to information needed for a particular task. In addition, for younger learners, it may be a more familiar, thus less daunting, means for communication and documentation of their thoughts and reactions. Learning management systems now provide methods to document thoughts via discussion or chat rooms, blogs, and tweets, as well as Web-based conference capability for visual and audio connections, and support for group work. Numerous software programs are available that offer interactive methods to learn specific topics such as anatomy. Virtual patient care settings that employ avatars have been developed to permit more realistic simulations of patient care. When used in conjunction with a well-designed learning experience, technology can enrich the experience. Selected examples of pharmacy programs that incorporate technology into coursework that is designed to develop critical thinking and problem solving skills can be found in Table 5.<sup>63,67</sup>

### Experiential learning component

Many articles in pharmacy education focused on critical thinking and problem solving skills concentrate on didactic courses. It should be noted that many of the classroom and lab methods for the development of critical thinking and problem solving skills can be applied in the experiential setting as well. Patient care is certainly the ultimate example of inquiry-based learning. The use of informal writing and activities that include reflection may not be as frequently employed in this component of the professional curriculum. This type of educational setting is a logical place to insert technology, such as in the use of an electronic portfolio, as a means to enhance development of critical thinking and problem solving skills.

### Need for research on instructional effectiveness

Part of the process of curricular incorporation of those instructional methods designed to promote the development of the critical thinking and problem solving is the assessment of their effectiveness. Such assessments require attention to study design, analysis methods, and measurement of student learning

outcomes. Cisneros and colleagues outlined specific gaps in our knowledge about the effectiveness of various instructional methods for the development of problem solving skills and called for additional research in these areas.<sup>73</sup> Their suggestions, which focused primarily on study design, included conducting more longitudinal studies of inquiry-based instructional methods, making comparisons to control groups, comparing across different schools, exploring the role of group learning, and using both quantitative and qualitative research methods. Because problem solving and critical thinking are complex behaviors, consideration of many factors in these studies will be needed if a complete understanding is to emerge. The authors also called for improved methods for measurement of student learning outcomes when inquiry-based instructional methods are employed despite the fact that several measurement instruments currently exist. These instruments are described in detail in the next section.

### **Methods to assess critical thinking skills**

As mentioned in an earlier section, one mechanism by which academic pharmacy measures critical thinking skills in their applicants is through the use of formal instruments, including the Watson-Glaser Critical Thinking Appraisal (WGCTA, Pearson), California Critical Thinking Skills Test (CCTST, California Academic Press), California Critical Thinking Dispositions Inventory (CCTDI, California Academic Press), and Health Sciences Reasoning Test (HSRT, California Academic Press). These instruments have been studied for application in admissions<sup>74-79</sup>, assessment of student pharmacists<sup>19,27,28,57,80</sup>, as well as in program assessment.<sup>81</sup> Other specialized assessment instruments have been developed and used to evaluate student pharmacists' performance in specific tasks. These instruments include a computer assessment program to evaluate problem solving and critical thinking skills in clinical decision-making<sup>80</sup>, an instrument based on Rasch modeling to evaluate critical thinking skills in scientific literature evaluation<sup>82</sup>, as well as an instrument designed to determine if self-assessment exercises improve critical thinking skills.<sup>31</sup>

The WGCTA, CCTST, and HSRT are multiple-choice question exams. The WGCTA assesses the respondent's ability to make accurate inferences, recognize assumptions, properly deduce, interpret information and evaluate arguments.<sup>83</sup> The CCTST provides a total score and reports five subscales: analysis, evaluation, inference, deductive reasoning, and inductive reasoning.<sup>84</sup> The CCTDI evaluates personal disposition to utilize critical thinking. The instrument is a list of reflective statements with the

application of a Likert scale for statement evaluation by the respondent. This instrument reports seven subscales: truth seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness, and cognitive maturity.<sup>85</sup> The HSRT is designed to assess critical thinking skills of health science students and professionals.<sup>86</sup> Test items frame professional and clinical practice without the requirement of prior content knowledge of the topic areas. The HSRT reports the same subscales (Health Sciences Reasoning Test Scale Descriptions)<sup>87</sup> as the CCTST.

The CCTST, utilized as part of the admissions process, was shown to be an effective predictor of student success.<sup>75</sup> Correlation was highest for student success in management, behavioral science, pharmacy practice, and experiential coursework. Total CCTST scores and subscores tested during the admissions process were found to be weakly but significantly predictive of P1 GPA.<sup>74</sup> The HSRT was studied in P1 student pharmacists with results compared to admission data.<sup>76-79</sup> Basak et al. employed both HSRT and WCGTA in two cohorts of students. While there was significant correlation between scores of the two exams, neither exam was found to be predictive of P1 GPA.<sup>76</sup> Smith et al. found that HSRT results were significantly correlated with Pharmacy College Admission Test data.<sup>78</sup>

Use of the WGCTA in P4 student pharmacists showed strong correlation with grade point average and performance in therapeutics coursework, but not with clinical problem solving skills.<sup>80</sup> Miller employed both the CCTST and CCTDI in assessment of the growth of critical thinking skills in student pharmacists through their academic career.<sup>28</sup> There was a significant increase in performance on the CCTST that demonstrates an increase in critical thinking ability, while there was no change in CCTDI performance that indicates no change in student disposition toward critical thinking. Further study of student pharmacists in a drug literature evaluation course showed correlation between their CCTST score and course grade and final examination grade.<sup>19</sup> Kidd and Latif found a strong correlation between CCTST score and P4 experiential course performance while CCTDI score correlated to classroom course performance.<sup>57</sup> Phillips et al. used both CCTST and CCTDI given to student pharmacists periodically during their academic careers.<sup>84</sup> The results compared well to national norms. A significant increase was seen for CCTST scores and performance on the CCTDI was shown to improve over time. The authors concluded that specific areas of performance strength and weakness could be used as a guide to curricular change in program assessment. A study of CCTST and CCTDI given to P1, P2, P3, and P4

student pharmacists showed no incremental change in one year.<sup>27</sup> However, significant changes were seen in the subscales inference (CCTST, decrease), open-mindedness (CCTDI, decrease), and self-confidence (CCTDI, increase).

## Conclusion

In this Report we recognize that critical thinking and problem solving skills are essential in the practice of pharmacy and that development of these competencies should, at the very least, be included within the professional pharmacy curriculum. Student exposure to a variety of well-designed instructional methods across the professional curriculum in a variety of settings is likely to reinforce the importance and general applicability of this skill set. In order to assess curricular effectiveness of development of these competencies, assessment of student capacity and disposition to use these skills is imperative. Longitudinal use of one or more of the existing critical thinking and problem solving evaluation tools along with stronger study designs may provide better insight into the progressive development of these competencies, as well as may provide direction for programmatic changes to reflect student strengths and weaknesses. As a component of this Report the Committee provides both recommendations and suggestions for consideration and potential implementation by AACP leadership.

## References

1. Brazeau GA, Meyer SM, Belsey M, et al. Future pharmacy graduates – making more opportunities than we see. *Am J Pharm Educ.* 2009; 73: Article 157.
2. Boyce EG, Lawson LA. White paper on the pre-professional curriculum in preparation for the doctor of pharmacy educational programs. *Am J Pharm Educ.* 2009; 73: Article 155.
3. Jungnickel PW, Kelley KW, Hammer DP, Haines ST, Marlowe KF. Addressing competencies for the future in the professional curriculum. *Am J Pharm Educ.* 2009; 73: Article 156.
4. Blouin BA, Riffée WH, Robinson ET, et al. Roles of innovation in education delivery. *Am J Pharm Educ.* 2009; 73: Article 154.
5. Farris KB, Demb A, Janke KK, Kelley K, Scott SA. Assessment to transform competency-based curricula. *Am J Pharm Educ.* 2009; 73: Article 158.
6. Sandars J, Morrison C. What is the net generation? The challenge for future medical education. *Med Teach.* 2007;29:85-88.
7. Prensky M. Digital natives, digital immigrants. Part 1. *On the Horiz.* 2001;9(5):1-6.

8. Oblinger DG, Oblinger JL, Eds. *Educating the net generation*. EDUCAUSE, 2005. Available at: [www.educause.edu/educatingthenetgen/](http://www.educause.edu/educatingthenetgen/). Accessed January 26, 2010.
9. Skiba DJ. The millennials: have they arrived at your school of nursing? *Nurs Educ Perspec*. 2005;25(6):370-371.
10. Borges NJ, Manuel S, Elam CL, Jones BJ. Comparing millennial and generation x medical students at one medical school. *Acad Med*. 2006;81(6):571-576.
11. McAlister A. Teaching the millennial generation. *Am Music Teach*. 2009;59(1):13-15.
12. Rideout VJ, Foehr UG, Roberts DF. Generation M<sup>2</sup>: media in the lives of 8- to 18-year olds. *A Kaiser Family Foundation Study*. January 2010. Available at <http://www.kff.org/entmedia/upload/8010.pdf>. Accessed January 26, 2010.
13. Annetta LA. Video games in education: why they should be used and how they are being used. *Theory Into Pract*. 2008;47:229-239.
14. Special Report: The Power of Gaming. Business Week. Available at: [http://www.businessweek.com/innovate/di\\_special/20070813thepowerof.htm?link\\_position=link28](http://www.businessweek.com/innovate/di_special/20070813thepowerof.htm?link_position=link28). Accessed January 26, 2010.
15. Oblinger DG. Games and learning. *EDUCAUSE Q*. 2006;29(3):5-7.
16. How the new generation of well-wired multitaskers is changing campus culture. January 5, 2007 Technology Forum; RT Sweeney, moderator. *The Chronicle of Higher Education*. 2007;53(18)B10. Available at: <http://chronicle.com/article/How-the-New-Generation-of/10203> Accessed May 10, 2010.
17. Hartman JL, Dziuban C, Brophy-Ellison J. Faculty 2.0. *EDUCAUSE Rev*. 2007;42(5):62-77
18. Commission to Implement Change in Pharmaceutical Education. Alexandria, VA: American Association of Colleges of Pharmacy; 1992. Background Paper II – Entry Level Curricular Outcomes, Curricular Content and Educational Process; p. 6. Accessed at <http://www.aacp.org/resources/historicaldocuments/Documents/BackgroundPaper2.pdf>, February 3, 2010.
19. Miller DR. An Assessment of critical thinking: Can pharmacy students evaluate clinical studies like experts? *Am J Pharm Educ*. 2004;68: Article 5.
20. Heywood J. Assessment in higher education: student learning, teaching, programmes and institutions. London: Jessica Kingsley; 2000.
21. Watson G, Glaser EM, Rust J. Manual of the Watson-Glaser critical thinking appraisal (UK Edition). London and San Antonio: The Psychological Corporation; 2002.
22. Facione PA. Critical Thinking: What it is and why it counts. Millbrae, CA: Measured Reasons and the California Academic Press; 1992, 2004, 2010.
23. Willingham DT. Critical Thinking: Why is it so hard to teach? *Arts Educ. Pol. Rev*. Mar/Apr 2008;109(4)21-29.
24. Halpern, DF. Assessing effectiveness of critical thinking instruction. *J of Gen. Educ*. 2001;50,270-286.
25. Facione PA. *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction, Executive Summary* Millbrae, CA: California Academic Press; 1990. Accessed at [http://www.insightassessment.com/pdf\\_files/DEXadobe.PDF](http://www.insightassessment.com/pdf_files/DEXadobe.PDF), February 3, 2010.

26. Dam G, Volman M. Critical thinking as a citizenship competence: Teaching strategies. *Learn. and Instruc.* 2004;14,359-379.
27. Cisneros, RM. Assessment of critical thinking in pharmacy students. *Am J Pharm Educ.* 2009;73 Article 66.
28. Miller DR. Longitudinal assessment of critical thinking in pharmacy students *Am J Pharm Educ.* 2003;67 Article 120.
29. Austin Z, Gregory P, Chiu S. Use of reflection-in-action and self-assessment to promote critical thinking among pharmacy students. *Am J Pharm Educ.* 2008;72 Article 48.
30. Ennis RH *Critical Thinking.* Upper Saddle River, NJ: Prentice-Hall;1996.
31. Paul R, Elder L. *Critical Thinking: Tools for taking charge of your professional and personal life.* Upper Saddle River, NJ: Prentice-Hall; 2005.
32. Browne MN, Stuart MK. *Asking the right questions: A guide to critical thinking.* Upper Saddle River, NJ: Pearson-Prentice Hall; 2004.
33. Paul R. *Foundation for critical thinking.* Santa Rosa, CA: Rinehart and Winston; 1993.
34. Pascarella E., Terenzini P. *How college affects students: Findings and insights from twenty years of research.* San Francisco: Jossey-Bass; 1991.
35. Halpern DF. Teaching critical thinking for transfer across domains; dispositions, skills, training, and metacognitive monitoring. *Am Psychol.* 1998;53:449-55.
36. Critical Thinking VALUE Rubric. Washington, DC: Association of American Colleges and Universities; 2010. Accessed at <http://www.aacu.org/value/rubrics/CriticalThinking.cfm>, February 3, 2010.
37. Bloom BS. *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain.* New York; McKay; 1956.
38. Problem Solving VALUE Rubric. Washington, DC: Association of American Colleges and Universities; 2010. Accessed at <http://www.aacu.org/value/rubrics/ProblemSolving.cfm>. February 3, 2010.
39. Accreditation Council for Pharmacy Education (ACPE). *Accreditation standards and guidelines for the professional program in pharmacy leading to the Doctor of Pharmacy degree.* 2007. [http://www.acpe-accredit.org/pdf/ACPE\\_Revised\\_PharmD\\_Standards\\_Adopted\\_Jan152006.pdf](http://www.acpe-accredit.org/pdf/ACPE_Revised_PharmD_Standards_Adopted_Jan152006.pdf). Accessed May 10, 2010.
40. Harris MF, Harrold MW, Giudici RA, Boni RL, Wu W, et al. Development and implementation of critical thinking assignments throughout a pharmacy curriculum. *Am J Pharm Educ.* 1997;61:1-11.
41. Popovich NG, Katz NL. A microteaching exercise to develop performance-based abilities in pharmacy students. *Am J Pharm Educ.* 2009;74(4) Article 73.
42. Powers MF, Jones-Walker J. An interdisciplinary collaboration to improve critical thinking among pharmacy students. *Am J Pharm Educ.* 2005;69(4) Article 70.
43. Halpern DF. Teaching for critical thinking: Helping college students develop the skills and dispositions of a critical thinker. In *New Directions for Teaching and Learning*, 1999 (80) 69-74.
44. Friedman CB, Lage G, Norwood J, Stewart J. Predictive validity of the pharmacy college admission test. *Am J Pharm Educ.* 1987;51:288-91.

45. Bandalos DL, Sedlacek WE. Predicting success of pharmacy students using traditional and nontraditional measures by race. *Am J Pharm Educ.* 1989;53:145-8.
46. Charupatanapong N, McCormick WC, Rascati KL. Predicting academic performance of pharmacy students: demographic comparisons. *Am J Pharm Educ.* 1994;58:262-8.
47. Chisholm MA, Cobb HH, Kotzan JA. Significant factors for predicting academic success of first-year pharmacy students. *Am J Pharm Educ.* 1995;59:364-70.
48. Chisholm MA, Cobb HH, Kotzan JA. Prior four year college degree and academic performance of first year pharmacy students: a three year study. *Am J Pharm Educ.* 1997;61:278-81.
49. Hardigan PC, Lai LL, Arneson D, Robeson A. Significance of academic merit, test scores, interviews and the admissions process: a case study. *Am J Pharm Educ.* 2001;65:40-3.
50. Kelley KA, Secnik K, Boye ME. An evaluation of the pharmacy college admissions test as a tool for pharmacy college admissions committees. *Am J Pharm Educ.* 2001;65:225-30.
51. Thomas MC, Draugalis JR. Utility of the pharmacy college admission test (PCAT): implications for admissions committees. *Am J Pharm Educ.* 2002;66:47-51.
52. McCall KL, Allen DD, Fike DS. Predictors of success in a doctor of pharmacy program. *Am J Pharm Educ.* 2006;70(5) Article 106.
53. McCall KL, MacLaughlin EJ, Fike DS, Ruiz B. Preadmission predictors of PharmD graduates' performance on the NAPLEX. *Am J Pharm Educ.* 2007;71(1) Article 5.
54. Houglum JE, Aparasu RR, Delfinis TM. Predictors of academic success and failure in a pharmacy professional program. *Am J Pharm Educ.* 2005;69(3) Article 43.
55. Cline RR, Mott DA, Schommer JC. Relationship between attitudes, demographics, and application decisions among pre-pharmacy students: An exploratory investigation. *Am J Pharm Educ.* 1999;63(1): 394-401.
56. Allen DD, Bond CA. Pre-pharmacy indicators of success in pharmacy school: grade point averages, pharmacy college admission test, communication abilities, and critical thinking skills. *Pharmacotherapy.* 2001;21:842-9.
57. Kidd RS, Latif DA. Traditional and novel predictors of classroom and clerkship success of pharmacy students. *Am J Pharm Educ.* 2003;67(4) Article 109.
58. Lobb WH, Wilkin NE, McCaffrey DJ, Wilson MC, Bentley JP. The predictive utility of nontraditional test scores for first-year pharmacy student academic performance. *Am J Pharm Educ.* 2006; 70(6) Article 128.
59. Marchand H. Some reflections on post-formal thought. *Genetic Epistemologist* 2001;29(3) Available at: <http://www.piaget.org/GE/2001/GE-29-3.html>. Accessed May 10, 2010.
60. Ross LA, Crabtree BL, Theilman GD, Ross BS, Cleary JD, Byrd HJ. Implementation and refinement of a problem-based learning model: A ten-year experience. *Am J Pharm Educ.* 2007;71(1) Article 17.
61. Hobson EH, Schafermeyer KW. Writing and critical thinking: Writing-to-learn in large classes. *Am J Pharm Educ.* 1994;58:423-27.
62. Earl GL. Using cooperative learning for a drug information assignment. *Am J Pharm Educ.* 2009;73(7) Article 132.

63. Lin SJ, Crawford SY. An online debate series for first-year pharmacy students. *Am J Pharm Educ.* 2007;71(1) Article 12.
64. Zdanowicz MM. The pharmacology of immunosuppression. *Am J Pharm Educ.* 2009;73(8) Article 144.
65. Monk-Tutor MR. Development of a problem-based learning course in human resources management. *Am J Pharm Educ.* 2000;65:64-73.
66. Reddy IK. Implementation of a pharmaceuticals course in a large class through active learning using quick-thinks and case-based learning. *Am J Pharm Educ.* 2000;64:348-54.
67. Vinita BP, Kelley KA, Bellebaum KL. Instructional Design and Assessment: A technology-enhanced patient case workshop. *Am J Pharm Educ.* 2009;73(5) Article 86.
68. Seybert AL, Kobulinsky LR, McKaveney TP. Human patient simulation in a pharmacotherapy course. *Am J Pharm Educ.* 2008;72(2) Article 37.
69. Persky AM. Multi-faceted approach to improve learning in pharmacokinetics. *Am J Pharm Educ.* 2008;72(2) Article 36.
70. Orr KK. Integrating virtual patients into a self-care course. *Am J Pharm Educ.* 2007;71(2) Article 30.
71. Cheng JWM, Kalis MM, Desselle SP, Feifer S. Comparison of the effectiveness of traditional lecturing and patient-based approach in pharmacy students' ability to apply revised treatment guidelines for hypertension. *Am J Pharm Educ.* 2002; 66:395-401.
72. Bouldin AS, Holmes ER, Fortenberry ML. "Blogging" about course concepts: Using technology for reflective journaling in a communications class. *Am J Pharm Educ* 2006;70(4): Article 84.
73. Cisneros RM, Salisbury-Glennon JD, Anderson-Harper HM. Status of problem-based learning research in pharmacy education: A call for future research. *Am J Pharm Educ.* 2002;66:19-26.
74. Adams EH, Leader GW, Jain G, Lawrence LW. Predictive value of California Critical Thinking Skills Test as to first year and cumulative GPA. *Am J Pharm Educ.* 2008;72(3)Article 72:87.
75. Allen DD, Bond CA. Prepharmacy predictors of success in pharmacy school: Grade point averages, Pharmacy College Admissions Test, communication abilities, and critical thinking skills. *Pharmacotherapy.* 2001;21(7):842-9.
76. Basak RS, McCaffrey DJ, Wilson MC. The use of critical thinking assessments in the prediction of academic performance. *Am J Pharm Educ.* 2008;72(3) Article 72:89-90.
77. Cox WC. The Health Sciences Reasoning Test as a tool to aid in the admissions process. *Am J Pharm Educ.* 2008;72(3) Article 72:77.
78. Smith FL, Grace SM, Kell C. Use of non-traditional assessments to reveal the relative value of PCAT versus GPA for admissions. *Am J Pharm Educ.* 2009;73(4) Article 57:32.
79. Zerilli T, Cicero L. New admissions procedure: Impact on the Health Sciences Reasoning Test scores of P-1 students. *Am J Pharm Educ.* 2009;73(4) Article 57:82.
80. Adamcik B, Hurley S, Erramouspe J. Assessment of pharmacy students' critical thinking and problem-solving abilities. *Am J Pharm Educ.* 1996;60:256-65.

81. Phillips CR, Chesnut RJ, Rospond RM. The California critical thinking instruments for benchmarking, program assessment, and directing curricular change. *Am J Pharm Educ.* 2004;68(4)Article 101.
82. Jackson TR, Draugalis JR, Slack MK, Zachry WM, D'Agostino J. Validation of authentic performance assessment: A process suited for Rasch modeling. *Am J Pharm Educ.* 2002;66:233-43.
82. Watson G, Glaser EM. *Watson-Glaser Critical Thinking Appraisal Manual.* San Antonio, TX: The Psychological Corporation; 1980.
83. Facione PA, Facione NC. *The California Critical Thinking Skills Test Manual.* Millbrae, CA: California Academic Press, 1998.
84. Facione PA, Facione NC, Sanchez CA. *The California Critical Thinking Disposition Inventory Test Manual.* Millbrae, CA: California Academic Press, 1994.
85. Health Sciences Reasoning Test Scale Descriptions, HSRT, Insight Assessment. Available at <http://www.insightassessment.com/Scales%20HSRT.html>. Accessed January 5, 2010.
86. Health Sciences Reasoning Test, Insight Assessment. Available at <http://www.insightassessment.com/9test-hsrt.html>. Accessed January 5, 2010.

Table 1: Definitions of Critical Thinking

Authors	Definition
American Philosophical Association Expert Panel	"We understand critical thinking to be 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>25</sup>
Ennis	"Critical thinking is reasonable reflective thinking that is focused on deciding what to believe or do." <sup>30</sup>
Paul and Elder	"Critical thinking is a mode of reasoning and judgment that uses and assesses goals and purposes, questions and problems, information and data, conclusions and interpretations, concepts and theoretical constructs, assumptions and presuppositions, implications and consequences, points of view and frames of reference." <sup>31</sup>
Browne and Stuart	"Critical thinking consists of an awareness of a set of interrelated critical questions, plus the ability and willingness to ask and answer them at appropriate times." <sup>32</sup>
Paul	"Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, synthesizing, or evaluating information gathered from, or generated by, observation, experience, reflection or communication, as a guide to belief or action." <sup>33</sup>
Pascarella and Terenzini	"Critical thinking is the ability to identify central issues and assumptions in an argument, recognize important relationships, make correct inferences from data, deduce conclusions from information or data provided, interpret whether conclusions are warranted on the basis of the data given, and evaluate evidence." <sup>34</sup>
Halpern	"Critical thinking is the deliberate use of cognitive skills and strategies that increase the probability of a desirable outcome in a given situation." <sup>35</sup>
Association of American College and Universities	"Critical thinking is a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion." <sup>36</sup>

Table 2: Critical Thinking Skills<sup>27</sup>

Skill	Definition	Pharmacy Example
Interpretation	To comprehend and express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures or criteria	<ul style="list-style-type: none"> <li>Identifying a drug therapy problem and describing why it is a problem.</li> <li>Constructing a way to organize patient information that is collected.</li> </ul>
Analysis	To identify the intended and actual inferential relationships among statements, questions, concepts, descriptions or other forms of representation intended to express belief, judgment, experiences, reasons, information or opinions.	<ul style="list-style-type: none"> <li>Identifying the similarities and differences between two potential drug therapies for a condition.</li> <li>Citing the support for recommendations that exist in guidelines.</li> </ul>
Evaluation	To assess the credibility of statements or other representations which are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions or other forms of representation.	<ul style="list-style-type: none"> <li>Comparing the strengths and weakness of drug therapy recommendations</li> <li>Determining the credibility of a piece of drug literature.</li> </ul>
Inference	To identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to deduce the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation.	<ul style="list-style-type: none"> <li>Based on a drug therapy recommendation, identify the potential adverse effects that could occur.</li> <li>Developing and implementing a method for continuous quality improvement in a practice.</li> </ul>
Explanation	To state and to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which one's results were based; and to present one's reasoning in the form of cogent arguments.	<ul style="list-style-type: none"> <li>Stating the results of a drug study and the way in which those results were obtained.</li> <li>Describing the rationale behind a drug therapy recommendation.</li> </ul>
Self-regulation	"Self-consciously to monitor one's cognitive activities, and the results deduced, particularly by applying skills in analysis, and evaluation to one's own inferential judgments with a view toward questioning, confirming, validating, or correcting either one's reasoning or one's results."	<ul style="list-style-type: none"> <li>Revisiting drug therapy recommendations after further analyzing a case.</li> <li>Checking one's self when listening to a patient to ensure what the patient is saying is understood, free of one's own opinions or bias.</li> </ul>

Table 3: Critical Thinking Dispositions<sup>25</sup>

Approaches to Life and Living
Inquisitiveness with regard to a wide range of issues
Concern to become and remain well-informed
Alertness to opportunities to use critical thinking
Trust in the processes of reasoned inquiry
Self-confidence in one's own abilities to reason
Open-mindedness regarding divergent world views
Flexibility in considering alternatives and opinions
Understanding of the opinions of other people
Fair-mindedness in appraising reasoning
Honesty in facing one's own biases, prejudices, stereotypes, or egocentric tendencies
Prudence in suspending, making or altering judgments
Willingness to reconsider and revise views where honest reflection suggests that change is warranted
Approaches to Specific Issues, Questions or Problems
Clarity in stating the question or concern
Orderliness in working with complexity
Diligence in seeking relevant information
Reasonableness in selecting and applying criteria
Care in focusing attention on the concern at hand
Persistence though difficulties are encountered
Precision to the degree permitted by the subject and the circumstances

Table 4. Examples of publications dealing with teaching/evaluating critical thinking in the pharmacy curriculum

<b>Author(s)</b>	<b>Approach</b>
Harris, et al <sup>40</sup>	Following a workshop for faculty during the summer, implement assignments in courses – biochemistry, therapeutics, pharmacy management, pharmaceuticals, pathophysiology, pharmaceutical analysis, and pharmacy administration – to ensure that critical thinking was taught and demonstrated throughout the curriculum.
Austin, et al <sup>29</sup>	Students in a fourth year BS in Pharmacy program in Canada were examined to determine whether self-assessment and reflection-in-action improve critical thinking.
Cisneros <sup>27</sup>	Determine whether first, second, third, and fourth year pharmacy students demonstrate improvement in the California Critical Thinking Skills Test over one year.
Miller <sup>28</sup>	Determine whether changes occur in critical thinking ability over the 4-year professional curriculum
Miller <sup>19</sup>	Determine whether students in a drug literature evaluation class evaluated research studies in a way similar to experts and whether critical thinking skills predicted which students thought more like experts.
Popovich and Katz <sup>41</sup>	Develop and implement a microteaching exercise in 2 semesters of a professional development series.
Powers and Jones-Walker <sup>42</sup>	Students enrolled in a jurisprudence and ethics course participated in a 3-hour session that focused on Edward de Bono's Six Thinking Hats method for critical thinking in order to provide a structure for group problem solving related to ethical issues.