Moving Critical Thinking Research into the Classroom:  
A Review of Related Research and Translation to Practice

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ABSTRACT

The question raised in this paper is: can engagement in critical thinking practices respond to the needs of educators in their quest to prepare their students for the societal problems students will likely encounter? The writers pose the thesis that incorporation of critical thinking into agricultural science education curricula does enhance the preparation of students as society-ready citizens. In support of this proposal, the history of critical thinking is traced from Socrates through several scholarly conversations including a recent definition posed by Norris and Ennis (1989) that suggests critical thinking is “reasonable and reflective thinking … focused upon deciding what to believe or do.” Strategies are provided to support critical thinking including discussions on reading, writing, essays, and visual representations. In addition, the assessment of critical thinking accomplishments is presented as well as the incorporation of critical thinking into a sample context (leadership education).
INTRODUCTION

Howe and Strauss (2000) noted in their book, Millennials Rising, that in 1995 students “engaged in what (was a) rapidly routine activity for American kids: (The students) sat down with bubble-sheet answer forms, picked up number-two pencils, and took a multiple-choice test.” Is the popular practice, as documented in Millennials Rising, providing future citizens and leaders with the skills they will need to solve local and global problems? The question raised in this paper is: can engagement in critical thinking practices respond to the needs of educators in their quest to prepare their students for the societal problems they will likely encounter? The researches for this paper chose to investigate critical thinking as one aspect that can be incorporated into a comprehensive educational scheme. The paper is organized to identify the history of critical thinking and document several methods for how critical thinking can be utilized by educators. The goal of the writers is to catalyze the use of critical thinking in agricultural education programs.

HISTORY AND EVOLUTION

The roots of critical thinking are linked to the teaching practices of Socrates, who 2,500 years ago, utilized a method of probing questioning that people could not rationally justify their confident claims to knowledge. Inadequate evidence or contradictory beliefs often lurked beneath many theories and common beliefs. Socrates established the fact that one cannot depend upon those in "authority" to have sound knowledge and insight. He demonstrated that persons may have power and high position and yet be deeply confused and irrational. He established the importance of asking deep questions that
probe profoundly into thinking before we accept ideas as worthy of belief (Paul, R., Elder, L., & Bartell, T., 1997).

Socrates laid the foundation for the critical thinking paradigm, or more specifically, to reflectively question common beliefs and explanations, carefully distinguishing those beliefs that are reasonable and logical from those which lack concrete evidence or rational foundation to support our belief. He established the importance of seeking evidence, closely examining reasoning and assumptions, analyzing basic concepts, and tracing out implications not only of what is said but of what is done as well (Paul et al., 1997).

Another significant contribution to critical thinking was made by the scholars of the French Enlightenment: Bayle, Montesquieu, Voltaire, and Diderot. (Paul et al., 1997). These intellectuals began with the premise that the human mind, when disciplined by reason, is better able to figure out the nature of the social and political world. An important aspect for these thinkers is that reason must turn inward upon itself, in order to determine weaknesses and strengths of thought. The French Enlightenment group valued disciplined intellectual exchange, in which all views had to be submitted to serious analysis and critique. They believed that all authority must submit in one way or another to the scrutiny of reasonable critical questioning.

Eighteenth Century philosophers extended the conception of critical thought even further, developing a sense of the power of critical thought and of its tools. In the 19th Century, critical thought was extended even further into the domain of human social life by Comte and Spencer. Applied to the problems of capitalism, it produced the searching social and economic critique of Karl Marx (Paul et al. 1997). Applied to the history of
human culture and the basis of biological life, the use of critical thinking led to Darwin’s *The Descent of Man, and Selection in Relation to Sex* (1871). Applied to the unconscious mind, it was also reflected in the works of Sigmund Freud. In addition, when critical thinking was applied to cultures, it led to the establishment of the field of anthropological studies.

The use of critical thinking continued its progression into the 20th Century when the understanding of the power and nature of critical thinking emerged in increasingly more explicit formulations. In 1906, William Graham Sumner published a study of the foundations of sociology and anthropology entitled *Folkways: a study of the sociological importance of usages, manners, customs, mores, and morals*. In his book, he documented the tendency of the human mind to think sociocentrically and he proposed a parallel tendency for schools to serve the function of social indoctrination. Sumner recognized the deep need for critical thinking in life and in education:

"Criticism is the examination and test of propositions of any kind which are offered for acceptance, in order to find out whether they correspond to reality or not. The critical faculty is a product of education and training. It is a mental habit and power. It is a prime condition of human welfare that men and women should be trained in it. It is our only guarantee against delusion, deception, superstition, and misapprehension of ourselves and our earthly circumstances. Education is good just so far as it produces well-developed critical faculty. A teacher of any subject who insists on accuracy and a rational control of all processes and methods, and who holds everything open to unlimited verification and revision, is cultivating that method as a habit in the pupils. Men educated in it cannot be stampeded. They are slow to believe. They can hold things as possible or probable in all degrees, without certainty and without pain. They can wait for evidence and weigh evidence. They can resist appeals to their dearest prejudices. Education in the critical faculty is the only education of which it can be truly said that it makes good citizens” (p. 632, 633).

John Dewey supported Sumner’s notion and expressed that humans had increased their sense of the pragmatic basis of human thought and grounded their actual human
purposes, goals, and objectives. Ludwig Wittgenstein indicated that humans increased awareness not only of the importance of concepts in human thought, but also of the need to analyze concepts and assess their power and limitations. From the work of Piaget, we have increased our awareness of the egocentric and sociocentric tendencies of human thought and the need to develop critical thought (see discussion in Paul et al., 1997).

Continued discussion occurred in multiple educational circles whose participants discussed and debated critical thinking over the past century. While many scholars attempted to clarify the definition of critical thinking, Norris and Ennis (1989) provided a concise definition: “reasonable and reflective thinking …is focused upon deciding what to believe or do”. Agricultural educators have attempted to define critical thinking over the past two decades. Cano and Martinez (1991 p. 24), defined critical thinking as “A set of thinking skills needed to answer a particular question.” While Rudd et al. (2000) proposed the following definition: “Critical thinking is a reasoned, purposive, and introspective approach to solving problems or addressing questions, with incomplete evidence and information, and for which an incontrovertible solution is unlikely” (p. 5).

Several of the agricultural education studies regarding critical thinking have explored the levels of cognition and higher order thinking. Cano and Martinez (1991) sought to determine the cognitive level of performance and the critical thinking abilities of agricultural education students. They found that all students scored the lowest on the critical thinking portion. They also found a linear relationship between critical thinking and grade level. Torres and Cano replicated the study with agricultural students from The Ohio State University and found that their section scores were lowest on the critical thinking portion of the Developing Cognitive Abilities Test. Torres (1999) reported that
Preservice teachers are more likely to emphasize basic and application thinking skills rather than skills and abilities that require critical thinking.

Friedel et al. (2006) found that teaching critical thinking skills did influence critical thinking skills scores among college students. Rudd, Baker and Hoover (2000) argued for greater study of critical thinking by agricultural educators and researchers, citing lower than expected scores for disposition to think critically among agricultural students, as well as the role critical thinking plays in making connections between areas of inquiry or drawing of inferences that can be utilized by faculty members in college classrooms (p. 2).

The historical summary, then, suggests that the tools and resources of critical thinkers have been vastly increased through thought and scholarly contributions. Hundreds of thinkers have contributed to its development. Each major discipline has made some contribution to critical thought. Yet for most educational purposes, it is the summing up of base-line common denominators for critical thinking to be merged into a common educational practice.

**READING AND WRITING**

As suggested by its historical ramifications, students should develop critical thinking skills in order to make decisions, solve problems, and succeed in careers (Dewey, 1933; Giancarlo & Facione, 2003; Torres & Cano, 1995). Learning content does not really occur until a student brings the content into his/her own thinking (Elder & Paul, 2002). Facione (1998) determined six core critical thinking skills: interpretation, analysis,
synthesis, explanation, evaluation, and self-regulation. Further, reading ability has been shown to be a predictor of critical thinking ability (Rollins, 1990).

Today’s students—actually all of us—must function effectively in an information and text-rich world (Alvermann, 2001; Kamil, 2003; Moore, Bean, Birdyshaw, & Rycik, 1999; National Governors Association (NGA), 2005; Snow & Biancarosa, 2004). On a daily basis in school and during their out-of-school lives, students navigate text genres that include informational text, narratives, electronic texts, music, video, and other forms of media. With the explosion of information, students must also possess the requisite skills that enable them to read, write, and think critically about this information.

Reading and writing are opposing sides of related cognitive processes. Reading involves the input of information from text sources. It is likened to a conversation with an author who is not here, not now, but whose ideas are present. Writing, on the other hand, deals with the output of information and ideas via written text. When we write, we write for a specific purpose and for a specific audience. That audience may be one, many, you, and/or me. As educators, we must maintain the core purposes for students’ writing, as well as their purposes for reading. Between these two processes, students cognitively process information by incorporating it into existing schema, by making connections between the new information and their lives, and by determining how to use the information to solve problems and create solutions.

Implications Found Within the Collision

Critical thinking is thought to occur in two dimensions: a disposition toward critical thinking and critical thinking skills (Giancarlo & Facione, 2003). The disposition
toward critical thinking is a personality trait that inclines a person toward thinking critically. This is relatively stable over the short-term, but may change over time (Facione, Facione, & Giancarlo, 1997). Critical thinking skills are those skills and competencies typically employed by critical thinkers (Facione, 1998).

In effect, many critical thinking skills may involve reading and writing skills as well. When considering Facione’s (1998) list of critical thinking cognitive skills and sub-skills, several of these are related to reading and writing. For example, today’s learners of all ages and stages must interpret text, analyze the arguments thereby contained in the text, evaluate the logic behind the arguments, make inferences, and ask questions about the text. When we think about critical thinking, we are often thinking about analyzing the arguments and logic presented in written or oral text.

The very nature of writing implies thinking critically. To simply create a sentence, one must think in binary form—the what of the sentence and what we are saying about it (Thompson, 2002). Too, when reading, readers must understand the meaning of sentence, both from the author’s perspective and for the purposes of the reader, as well as what the author is proposing about to say about the it of the sentence. While many of us have taken reading and writing for granted these are complex cognitive tasks, requiring significant allocation of mental resources and concentration. Further, the relatively simplistic task of reading a single sentence may require high levels of critical thinking.

A “Critical” Perspective

Provided the plethora of information readily available to today’s learner, one must take care to think critically about that information. For example, an information consumer
can search online for information about Lyme disease, commercial lawn mowers, or star-nosed mole control in lawns; and within milliseconds, s/he can retrieve literally millions of websites with information on the topic. Yet, not all of this information is of equal value or even equal validity. Helping students understand that they must think critically about the information they read is vital to their future success.

It is essential for educators to help pre-service and experienced teachers understand how to interpret suppositions, analyze ideas, evaluate arguments, and question the authors of the materials that they read. In agricultural science education, our content and course materials are dynamic and change with new advances in the field of agriculture and life sciences. Thus, we often rely upon text outside of the textbook. This information is often targeted toward consumers, thus is suspect for biased claims and illogical logic. Even textbooks in agriculture are written by authors with biases. Textbooks also tend to become out-dated, thus require a higher level of critical reading in order to determine if the information contained in the text makes sense from our current perspective.

As agriculturalists in America, our words are often measured from various lenses. In agricultural education, our words tend to align with production agriculture. We tend to support the ideas like conservation, not preservation; traditional production, not organic production; and economies of scale, not local sustainability. For our student writers, these often conflicting ideas pose challenges to their critical thinking abilities and dispositions when writing. When asking students to write in agriculture, agricultural science teachers of all ages must remember the perspective portrayed by agriculture with mainstream audiences.
Reading and Writing Strategies

What can professors and teachers in agricultural education do to promote students’ critical thinking skills in reading and writing about agriculture? A handful of strategies may prove effective in helping scaffold the learning experiences of our students. From a reading perspective, the relatively simple K-W-L chart will help students identify what they know and what they want to know about the topic they are reading. This helps students activate background knowledge and develop questions to answer when reading. In doing so, we are addressing the critical thinking sub-skills of clarifying meaning, examining idea, assessing claims, and conjecturing alternatives. Following reading, when filling out the $W$ column, students identify what they learned, thus bolstering the presentation of arguments, drawing of conclusions and summaries, and self-examination.

Further, the act of writing summaries can help students assess claims, analyze arguments, and especially explain their thinking. While writing summaries may be taken for granted after reading a popular press article about agriculture, students should be explicitly taught to state the results of the article, justify the logic used in the article, and present the author’s arguments, as well as any confounding arguments presented by the student author. When structured appropriately, writing allows the students not only to analyze the author’s arguments, but also to analyze their own thinking, part of self-regulation.

Also concerning self-regulation, high school agriculture and college teacher education students alike should be encouraged to maintain a learning journal. In this journal students have the opportunity to reflect on what they are learning in classes and
make connections between the concepts in class and their lives outside of classes. Learning journals allow students to identify new and intriguing concepts in their agriculture courses. Students can attach meaning and significance to these concepts by reflecting upon their uses outside of school, their relationships with ideas from other courses, and their applications to current and future careers.

When we think about critical thinking skills, we are inherently considering them within applications of reading, writing, and literacy. With some of the newer ideas about literacy, researchers and practitioners think of literacy as more than reading and writing, a definition that often encompasses constructs like critical thinking. Thus, if we desire to foster literate critical thinkers within our future agriculture teachers and their students, we must equip them with the skills, strategies, and cultures that support those goals. Reading and writing strategies, when applied to agricultural science education, develops students who are literate and critical in their thinking.

THE ART OF QUESTIONING

A workshop on increasing critical thinking in the classroom was held recently at a Research I Land Grant university. As part of the workshop, participants were asked to write and share the important unanswered questions in each of their respective fields. When asked to share those questions, a physics professor in attendance stated, “There are no unanswered questions in our field. All of the questions have been answered” (Townsend, 2007).

Contrast response with the experience of Isidor Rabi, the 1944 Nobel Prize winner in physics as related by King (1995). Dr. Rabi told the story of how his mother
influenced the development of his questioning mind. Rather than ask him what he had learned each day as he returned home from school, she asked him what good questions he had asked that day. It is clear that his ability to ask questions helped him form his line of inquiry in magnetic resonance and research leading to the development of the laser beam and the atomic clock (Nobel Foundation, 1964).

It is unlikely a person who believes all of the questions have already been answered will pursue a line of inquiry leading to a new discovery worthy of the Nobel Prize. Although as agricultural educators, our primary focus is not necessarily to help develop the next line of Nobel Prize winners, is it important that our students develop the ability to ask thoughtful questions. If so, why is it important for students to develop the ability to ask thoughtful questions? What are those thoughtful questions? How can educators best help students develop their ability to ask thoughtful questions?

Teachers have used questions as a primary teaching method for many years. Gall (1970) reported that students in school one century ago spent approximately four-fifths of their instructional time involved in question asking and answering, with a teacher asking nearly 400 questions per day. One half century later, the number of questions asked by a teacher had decreased only slightly to 365 questions per day. But does asking questions in and of itself assist students in accomplishing critical thinking as defined by Paul and Elder in 2006: “analyzing and evaluating thinking with a view to improve it? (p. 4). This definition of critical thinking provided by Paul and Elder as well as the various other definitions of critical thinking solicit students to ask and respond to questions that push the learner to investigate her or his beliefs and to examine the evidence and reasoning offered for statements that have been presented as truth. Researchers such as Gall (1970)
found that, although questions are utilized in the classroom setting, critical thinking processes were not engaged. He reviewed the categorization and investigation of questions asked in classrooms and found that in the first half of the twentieth century, the types of questions remained relatively unchanged, with 60% of questions asked by teachers categorized as “fact recall,” 20% of questions categorized as “procedural,” and only 20% of questions actually requiring students to think. More recent studies (Savage, 1998) have suggested that while the large majority of time in classrooms is spent asking questions, 70 to 80 percent of the questions asked required factual recall in spite of evidence suggesting that 80 to 90 percent of those facts are readily forgotten by students.

As defined, questioning is central to the process of developing critical thinkers. However, in order for students to become “self-directed, self-disciplined, self-monitored, and self corrective” thinkers (Paul & Elder, 2006, p. 4), teachers should ask questions that require students to think about their thinking, beliefs, biases, assumptions, and interpretations. In establishing the need for teaching critical thinking in athletic training education, Walker (2003) stated, “Questions are only as good as the thought put into them and should go beyond knowledge level recall. Questions should be designed to promote evaluation and synthesis of facts and concepts” (p. 264).

Ikuenobe (2001) stated, “Questioning implies a process of continuously opening up issues about the reasonableness of a belief; it requires providing better evidence or counter-evidence” (p. 331). The use of questioning to encourage critical thinking is typically credited to Socrates (Ikuenobe; Metaphysics Research Lab, 2005; Overholser, 1992). Socrates posited that in solving a problem, one should ask a question and when finding the answer, an answer to the problem is discovered. This logic provided the
foundation for the Scientific Method, in which the first step requires statement of the problem in the form of a question. The Socratic Method poses a series of questions to help a person or group to determine their underlying beliefs and the extent of their knowledge (Metaphysics Research Lab, 2005). According to Overholser (1992) the Socratic Method can be a powerful instructional tool. He stated, “the elements of "applied Socrates" are very appropriate to classroom settings and can promote an active learning environment in which students learn to evaluate information and develop a more sophisticated approach to various problems. Although empirical support is needed to evaluate and refine the benefits of the Socratic Method, it is clear that it promotes creative and critical thinking and fosters a collaborative learning atmosphere” (p. 19).

In implementing higher level questioning to promote critical thinking, Walker (2003) suggested that instructors: ask questions that require higher order thinking (e.g., Bloom’s Taxonomy levels of analysis, synthesis, and evaluation); ask questions that explore the meaning of a claim, position, or line of reasoning; ask questions that investigate assumptions, viewpoints, consequences, and evidence; call on students who do not have their hands up; ask another student to summarize the previous answer; and avoid asking questions with one set answer.

King (1990) suggested the use of a guided peer interaction and reciprocal questioning as a method for improving the critical thinking skills and peer interaction in college level courses. Following a lecture involving expository material, students were separated into small groups and were provided with a guided method of asking questions to others in the group and answering the questions posed by other group members. Results of King’s study suggested that students involved in the guided reciprocal
questioning activity asked more critical thinking questions as compared with recall questions, provided more explanations of the material, and had higher achievement levels when compared with students involved only in small group discussion.

Following the “Socratic Method,” teachers are encouraged to use questions that will expose errors in the students’ reasoning or beliefs and to establish an environment in which if the teacher makes an error of logic or fact, it is acceptable for a student to correct the teacher. Overholser (1992) recommended establishing an active learning atmosphere early to prevent students from developing a passive attitude in class. He further suggested that students have at least a basic level of background information, typically provided through a brief lecture format. Once the information needed to lay the foundation for advanced thinking has been provided, the teacher and students can discuss more advanced concepts or complex applications, and explore controversial issues. He also recommended using required readings in graduate classes as a means of providing the relevant background information, allowing the classroom meetings to be used as a forum for discussion using the Socratic Method. Overholser stated, “Although the Socratic process can be threatening to some students, in my experience it has been well received. It not only allows--in fact, it strongly encourages--the active participation of students” (p. 19).

Further, Ikuenobe (2001) suggests the following: instructors can motivate questioning by explaining to students its logic, functions and basis as an epistemic process; instructors should make explicit to students the connections among questioning, critical thinking, inquiry and learning; instructors have to develop a constructive and non-threatening way to ask questions and teach students a process of asking questions; and
instructors must create a classroom environment conducive for students to express themselves.

In summary, students “must be given the opportunity to actively participate in their own learning process, which involves acquiring the skills of questioning for the purpose of bringing about understanding, growth and progress in knowledge. By questioning texts, views, assumptions and beliefs, students may be able to learn the process of inquiry and acquire the ability and disposition of critical thinking” (Ikuenobe, 2001, p. 340). Involving students as active participants in their learning and in developing their abilities to ask and search for the answers to higher level cognitive questions, instructors can assist students in developing critical thinking and the inquiry process, much like Isidor Rabi’s mother assisted in his development.

INTEGRATION WITH LEADERSHIP EDUCATION

One context that demonstrates the use of critical thinking is leadership education. Numerous authors have connected critical thinking to leadership. This section describes several positions for how critical thinking supports leadership, identifies ways that college courses and programs can promote students' critical thinking, and explains methods for helping adult learners increase critical thinking.

Critical Thinking as a Component of Leadership

Critical thinking has been included in several theories of leadership and leadership education models. Transformational leadership theory plays a dominant role in leadership research (Judge & Bono, 2000). Transformational leaders "motivate followers
to work for transcendental goals that go beyond immediate self-interests" (Bass, 1997, p. 133). Bass identified four interrelated components of transformational leaders: idealized influence, inspirational motivation, intellectual stimulation, and individual consideration. Critical thinking and the promotion of critical thinking in followers play a central role in the intellectual stimulation component (Northouse, 2004).

Ricketts and Rudd (2002) proposed a model for youth leadership curriculum. The model provided guidance for the teaching, training, and developing of leadership in youth. The model included five dimensions: (1) leadership knowledge and information; (2) leadership attitude, will, and desire; (3) decision making, reasoning, and critical thinking; (4) oral and written communications skills; and (5) intra and interpersonal relations. While initially targeted for youth leadership programs, the model can be applied to leadership development broadly and has been effective in guiding undergraduate leadership development (Ricketts & Rudd).

Latour and Rast (2004) approach the topic from a different angle. They start with the premise that leading is tied to following and "the reality is that we fulfill both roles simultaneously" (Latour & Rast, p. 1 of 11). Based on their review of the followership and follower development literature five follower competencies and components were identified: (1) displays loyalty, (2) functions well in change-orientated environments, (3) functions well on teams, (4) thinks independently and critically, (5) considers integrity of paramount importance. Similar to the work on transformational leadership and leadership development, critical thinking was identified as a key component. From these conceptual models of critical thinking flow the practical applications in developing educational programming to build critical thinking for leadership and followership.
Leadership Courses and Curricula

If critical thinking plays an important role in leadership, then leadership courses and curricula need to promote students' development of critical thinking skills. On the global level, Leung and Kember (2006) linked graduates' perceptions of increased critical thinking capability to active teaching, teaching for understanding, and quality teacher-student relationships. For programs that aspire to develop students' critical thinking skills, these results indicate the need to move from a model focused on transmitting knowledge through lecture to one where students play an active role in the learning process.

Burbach, Matkin, and Fritz (2004) examined change in students' critical thinking skills at the course level. They studied the impact that an "introductory level college leadership course that encouraged active learning" (Burback, Matkin, & Fritz, p. 2 of 11) had on critical thinking test scores. The researchers found a statistically significant increase in students' critical thinking skills from the start to end of the semester. Teaching strategies utilized in the course included an extensive service learning project, journals, small group projects (contextual scenarios, case studies, role-plays, and presentations), and Socratic questioning.

Based on the findings of Leung and Kember (2006) and Burbach, Matkin, and Fritz (2004), the path to increasing student critical thinking ability lies in the instructional techniques used. Active learning methods where the teacher becomes "a guide on the side rather than a sage on the stage" (Thomas, 1992, p. 54 as cited in Kerka, 1992) need to be utilized. Examples of active learning strategies include:

- Case studies
- Cooperative learning
• Presentations
• Role-plays
• Service learning projects
• Socratic questioning
• Team based learning

Student pair activities provide a safe starting point for instructors wishing to make the transition to active learning (University of Minnesota Center for Teaching and Learning, 2006). As discussed in other sections of this paper, questioning and writing can also be used to teach critical thinking.

Adult Leadership Education Programming

Adult and continuing educational programs with a leadership focus should also consider participants' critical thinking ability. Franz (2002) identified the need for extension educators to continually develop critical thinking ability. Activities suggested to meet this demand were action learning, scenario building, and the use of metaphors. The use of technology to facilitate critical thinking development and to promote related dialogue across the organization was also promoted.

Smith (2001) took a similar approach in his work with development programs for business leaders. His action learning model utilizes small groups who tackle real problems within the business. Just-in-time delivery of tools that promote reflection helps to reinforce the experiential learning cycle in this model. Key tools include participant dialogue, problem analysis techniques (ex. force field analysis, cause and effect diagrams, mind mapping), and processes to overcome defensive thinking.

Another tool for promoting reflective thinking is the personal analysis titled Strengths-Weaknesses-Opportunities-Threats (SWOT). Patterned after the classic
organizational strategic planning tool, a personal SWOT analysis asks the individual to identify internal characteristics (strengths and weaknesses) and external environmental factors (opportunities and threats). The process of personal SWOT analysis has been adapted to career development, teacher development, and academic skills development (Battles, 2006). Adapting this framework to leadership development is a logical step in developing critical thinking for leaders. The personal SWOT addresses at least 2 components of transformational leadership (Bass, 1997, p. 133): intellectual stimulation, and individual consideration. Therefore, the leadership education context is a demonstrated and purposeful illustration of how critical thinking is incorporated into an agricultural and life sciences program.

ASSESSMENT STRATEGIES

Each suggested critical thinking educational activity is only as good as its effectiveness. In order to design an assessment program for critical thinking, a review of several definitions of critical thinking are reviewed. Ennis (p. 180, 1993) provides a good definition of critical thinking calling it “reasonable reflective thinking focused on deciding what to believe or do.” Williams (2005) warned unless critical thinking is modeled and approached as a requirement within the classes in a teacher education program, teachers will not model it for or expect it from their students. Ennis (1993) further states while many educators agree critical thinking must be infused into the curriculum, many admit they are not certain how to best assess the action. Paul and Elder (p. 3, 2004) share while there is a close relationship between creative and critical thinking, there remains a clear distinction with the former being the originator of
information and the latter as the assessor of it. According to Paul and Elder, nine intellectual standards should be implemented to adequately assess one’s ability to think critically (p. 26, 2004). Those nine areas include: “clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness.”

People do not necessarily develop critical thinking skills naturally and many adults lack the reasoning skills they are theoretically expected to have (Angelo, 1995; de Sanchez, 1995). Anything a teacher can do to encourage student engagement in the three highest levels of Bloom’s Taxonomy, metacognition, and problem solving will help develop this area (Hanley, 1995). Angelo (1995) advises teachers to use classroom assessment as a method for regularly surveying student learning to aid in the process. A variety of assessments are available and the type of student learning objective being appraised will dictate which is best suited. The following forms of assessment can help educators tap into those key standards Paul and Elders (2004) said were important to student learning and success.

Opportunities for a Transfer of Learning

Halpern (1993) states “the goal of critical-thinking instruction is to produce students who have become better thinkers in the real-world contexts that extend beyond the usual in-class exam (p. 273, 1993). Ennis (1993) reports few high stakes tests were generated with the goal of assessing students’ critical thinking. As a result, students can share what they know while remaining in the lower levels of Bloom’s Taxonomy. To incorporate more critical thinking, teachers can assess student understanding of course content by challenging them to apply their knowledge to situations beyond the classroom
context. This provocation compels them to tap into higher order thinking as they seek ways to extend their knowledge.

Essays

Depending on the scenario posed, the teacher can evaluate different critical thinking skills by having the student generate more extensive, well-constructed writings. The essay prompt’s degree of structure will dictate the level of critical thinking targeted (Ennis, 1993). For example, the student may be asked to outline the process which led to the scenario described in the assessment. This highly structured alternative is intended to assess the student’s ability to theorize yet limits the logical possibilities available for constructing the speculation. Another option would be to have a student respond to a scenario by taking a particular position or he may even need to refute an argument posited by the test writer. This moderately structured activity assesses the student’s ability to evaluate truth and formulate logical lines of reasoning, thus opening more options for student creativity.

Minute Papers

This quick writing activity is used at the end of a class meeting to encourage students to consider what they have gained from the session and identify any gaps in their understandings (Angelo, 1995). The teacher provides a couple of stem statements or questions to encourage self assessment. Once the students have adequately reflected on the stem, each writes a brief response and turns the comments in to the teacher. The teacher then reviews the responses and generates a reply to be delivered to the students at the beginning of the class the following day. This tool opens a space for dialogue to
evolve between student and teacher, resulting in a greater efficiency and clarity of the teaching-learning process.

Multiple Choice Items with Open-ended Justification

Many educators find multiple choice test items to be an effective way to assess student understanding of course content, as well as a time saver when it comes to grading (Ennis, 1993). Assessments relying solely on forced-choice response tend to reduce the level of critical thinking required of a student. Insisting students mark their choices and write a short justification of each opens an opportunity for the student to share his thought process with the teacher. It is probable answers not requiring justification to be marked wrong due to the differences and separation between the teacher and the student. It is possible for responses offered with a justification to result in a correct mark simply because the veil of anonymity between the two has been lifted and the student can invite the teacher to consider other paths to knowing.

Visual Representations

Ennis (1993) offers a list of characteristics he believes are central to the definition for “critical thinking”. This lengthy list of ten items boasts a series of high-level cognitive feats not common in many class experiences including formulating a sound position on a matter, as well as being open to alternate points of view. Also among those characteristics are the abilities of drawing conclusions about, and ascribing value to, information received. These abilities are engaged through a deep level of understanding which

Because it shows how a student creates meaning and, in some cases, new knowledge; concept mapping can be used to assess critical thinking. There are many ways of knowing and therefore many paths to a solution so concept mapping forces students to make decisions regarding how their concept will be displayed. This means a student must consider how the information needs to be portrayed to respond to the task at hand, decide which information is most appropriate for doing so and being he transfer from his memory to a visual means by which the idea may be communicated to others.

Gowan’s Vee Diagram is another alternative to test a student’s ability to “unpack, analyze, and critically evaluate complex knowledge and value claims” (Mintzes & Novak, p. 41, 2000). This assessment tool begins with a v-shaped template the student completes as he formulates his own ideas and understandings of the information he received and evaluated. As artifacts of the student’s mental processing, completed diagrams reveal how the student learned and applied the learning to other situations. A double benefit is the teacher may take the information to inform his own practice.

The action immediately following assessment feedback is where the real power for critical thinking development lies (Angelo, p.7, 1995). The information gained from such tools can be used by the teacher to make better decisions about matching teaching strategies with student readiness levels in an effort to be more purposeful with class time. It isn’t enough to acknowledge the findings; they must also be shared with the student. The student can also make use of the information to gain a deeper understanding of the
content by making connections beyond the course, and by developing greater autonomy as learner.

CONCLUSIONS AND IMPLICATIONS

The history and progression of critical thinking blends with the advancement of global societies. Wolcott (2006) suggested that true critical thinkers are titled as “Strategic Re-Visioners” and noted that these thinkers “proceed as if (the) goal is to construct knowledge, … move forward toward better conclusions… as (a) problem is addressed over time (p. A-3). A historical review builds a bond between the foundations of critical thinking and curriculum development. Following the historical scholars’ developments, agricultural educators are able to blend into their specific teaching contexts methods that utilize reading, writing, questioning, essays, minute papers, and visual representations. In addition, one may chose to simulate the concepts from a specific context (i.e. leadership education) to identify critical thinking enhancements to a particular setting. Students enrolled in agricultural education programs have an immense challenge to solve problems in energy development, food processing, food distribution, and other life sciences related progress. As Wolcott (2002) suggests, it is the responsibility of educators to “integrate skills into on-going process(es) for generating and using information to guide strategic innovation.” Critical thinking leads to strategic innovation and positive change for society. Educators are, therefore, challenged to use critical thinking to move their students toward creating positive change in the global society.
References


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