

AN INVESTIGATION OF THE CRITICAL THINKING ABILITY OF SECONDARY AGRICULTURE STUDENTS

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Abstract

The purpose of this study was to examine the relationship between student characteristics and critical thinking. Additionally, this study sought to determine the unique variance in critical thinking explained by achievement level. The target population for the study was identified as secondary agriculture students. As part of a larger study, the sample consisted of 105 secondary agriculture students purposefully selected based on characteristics of the teacher. Critical thinking ability was determined by the Watson-Glaser Critical Thinking Appraisal[®] (WGCTA[®]) (Form S). Mean scores for critical thinking indicate that some level of critical thinking is present in secondary agriculture students. Males and females were similar in their ability to think critically. Upper classmen outperformed lower classmen on critical thinking. Students categorized as higher academic achievement levels exhibit higher critical thinking skills than those students categorized as lower achievement levels. Academic achievement level uniquely contributed 18 percent of the variance in critical thinking score.

Introduction and Theoretical Framework

Education has long focused on teaching students to give a correct answer. Students often complete assignments, do well on tests and get good grades; yet, do not learn to think critically (Brooks & Brooks, 2001). According to Brooks and Brooks (2001), teachers too often ask students to recite, define, describe, or list facts. Students are less frequently asked to analyze, infer, connect, synthesize, evaluate, think and rethink. Students have become familiar with this process of passing knowledge back and forth without inquiring into how this information applies to the real world (Black & Deci, 2000). The concern over development of critical thinking skills, or lack thereof, has led to a renewed focus of education.

The current educational climate reflects the importance of learning not only content information, but also developing skills for thinking critically (Pithers & Soden, 2000). The need for instructional design to improve the thinking process has been substantiated in numerous reports over the last 25 years (Halpern, 2003). In recent years, more emphasis has been placed in the student's ability to understand and use information, not to merely possess it (Richardson, 2003). Furthermore, college faculty identified critical thinking, along with problem solving, as skills necessary for every college graduate (Diamond, 1997).

While there appears to be unanimous agreement regarding the importance of developing students' critical thinking skills, there is much less agreement on exactly what constitutes critical thinking. The concept of critical thinking was reflected in the teaching of Greek philosophers such as Socrates, Plato and Aristotle (Burbach, Matkin, & Fritz, 2004; Staib, 2003). Dewey (1909, 1997) described critical thinking as the suspension of judgment and healthy skepticism. Multiple descriptions of critical thinking can be found in the literature (Beyer, 1987; Burden & Byrd, 1994; Ennis, 1962; Halpern, 2003; Pascarella & Terenzini 1991; Simon and Kaplan, 1989; Stahl & Stahl, 1991). Critical thinking is often linked with, compared to, and used interchangeably with problem-solving (Dressel & Mayhew, 1954; Facione, 1990; Moore & Parker, 1994; Pascarella & Terenzini, 1991; Sternberg & Baron, 1985) and higher order thinking (Burden & Byrd, 1994; Ennis, 1985; Facione, 1990; Whittington, Stup, Bish, & Allen, 1997).

Early efforts of Dressel and Mayhew (1954) established a framework for evaluating critical thinking. Their work identified five abilities associated with the concept of critical thinking. Building on the work of Dressel and Mayhew, Watson and Glaser (1994) provided the following definition:

Critical thinking is a composite of attitudes, knowledge, and skills which includes: (1) attitudes of inquiry that involve an ability to recognize the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true; (2) knowledge of the nature of valid inferences, abstractions, and generalizations in which the weight or accuracy of different kinds of evidence are logically determined; and (3) skills in applying the above attitudes and knowledge. (p. 9)

Consistent with this definition, Watson and Glaser created a data collection instrument to measure those skills associated with critical thinking. The Watson-Glaser Critical Thinking Appraisal[®] (WGCTA[®]) (1994) measures critical thinking through five abilities: inference,

recognition of assumptions, deduction, interpretation, and evaluation of arguments. Each of the five abilities is represented by a score on a sub-test of the instrument; and collectively, they represent an ability to think critically.

A Nation at Risk (National Commission on Excellence in Education, 1983) questioned the faltering achievement of American students and called for investigations into existing educational structures. The National Commission on Excellence in Education specifically identified concerns about students' lack of ability in critical thinking, higher-order thinking and problem solving skills. This concern over students' ability to think critically was further substantiated by Norris (1985), who indicated that critical thinking was lower than expected in the United States at every stage of schooling.

The importance of critical thinking has been reinforced by industry expectations. The Secretary's Commission on Achieving Necessary Skills (SCANS) (1991) addressed this issue in their report entitled *What Work Requires of Schools*. The commission found that high performance workplaces required competencies in critical thinking. Among those critical thinking competencies identified were creative thinking, decision making, problem solving, and reasoning (SCANS, 1991).

Support for the development of critical thinking skills has also been apparent in the expectations of student performance in public schools. As a result of legislation, the Missouri Department of Elementary and Secondary Education (DESE)(1996) developed the Show-Me Standards outlining expectations of secondary students. These standards were a result of Senate Bill 380, "The Outstanding Schools Act" (1993), which called for the State Board of Education to adopt performance standards. The Show-Me Performance Standards target the development of critical thinking skills.

The standards are categorized into four goals. Goal one of the Show-Me Standards (DESE, 2004) states, "Students in public schools will acquire the knowledge and skills to gather, analyze, and apply information and ideas"(p. 3). In addition, Goal Three of the Show-Me Standards posits, "Students in public schools will acquire the knowledge and skills to recognize and solve problems"(p. 3). Finally, Goal Four asserts, "Students in public schools will acquire the knowledge and skills to make decisions and act as responsible members of society"(p. 3). The value of critical thinking skills is evident by the references to analysis, problem solving, and decision making in three of the four goals.

Critical thinking has been examined through a variety of perspectives. Early studies in agricultural education sought to identify the critical thinking ability of students enrolled in secondary agriculture classes. Findings indicated that secondary agriculture students did possess some ability to think critically (Rollins, 1990, Cano, 1990). Future studies have since contributed to what Cano initially described in 1990 as a shallow research base.

Studies have explored the relationship between critical thinking and student characteristics. Torres and Cano (1995) reported that learning style explained significant variance in critical thinking. In contrast, Rudd, Baker; and Hoover (2000) found no significant difference in critical thinking by learning style. However, they did find gender to be a significant

contributor to critical thinking disposition. More recently, Meyers and Dyer (2004) found no difference in student's disposition to think critically by gender or learning style.

Stronger connections have been made between critical thinking and academic ability. Rollins (1990) found the best indicator of critical thinking ability in Iowa secondary agriculture students to be the score on the Iowa Tests of Education Development (ITEDs) reading sub-test, accounting for 28% of the variance in critical thinking score. Cano and Martinez (1991) reported a substantial positive relationship between critical thinking and cognitive ability as defined by the Developing Cognitive Abilities Test. Ricketts and Rudd (2005) identified grade point average, as an indicator of academic performance, as the best known indicator for explaining critical thinking.

Critical thinking continues to emerge as a primary focus in education. While the body of literature related to critical thinking continues to grow, there continues to remain disagreement of factors that are associated with the ability to think critically. One consistent product of previous studies on critical thinking has been the call for continued investigation.

Purpose and Objectives

The purpose of this study was to examine the relationship between selected student characteristics and critical thinking. Additionally, this study sought to determine the unique variance in students' critical thinking explained by their achievement level. The following research objectives guided the study.

1. Describe selected characteristics (gender, grade classification, achievement level, and grade classification) of secondary agriculture students.
2. Explore critical thinking scores according to classifications of gender, grade classification, and achievement level.
3. Explain the variance in critical thinking score accounted for by achievement level ability when controlling for differences in gender and grade classification.

Methods and Procedures

Population and Sample

This study was part of a larger investigation and utilized a descriptive correlational design. While the target population for the study was identified as secondary agriculture students in Missouri, participants were limited by the design of the larger study. Subjects in the study were part of a purposive sample. Students were included in the study based on selection criteria of their agriculture teacher. Twelve teachers were selected based on characteristics of their teacher preparation program. All selected teachers had been exposed to a similar pre-service departmental philosophy of education, completed similar requirements for teacher certification, and received similar instruction in teaching methodology. The resulting sample consisted of 140 students. Achievement score data were unavailable for 35 students resulting in a usable sample for this study of 105. Due to the limitations of the sampling procedures,

findings from this study are representative of subjects included in the study and should not be generalized beyond this sample.

Instrumentation

Two data collection instruments were used. Critical thinking ability was determined by the Watson-Glaser Critical Thinking Appraisal[®] (WGCTA[®]) (Form S). The WGCTA[®] is a standardized, copyrighted, assessment tool for assessing the success of programs and courses in developing critical thinking skills (Watson & Glaser, 1994). The instrument includes exercises which are purported to be examples of problems, statements, arguments and interpretations of data which are regularly encountered at work as well as at school and in other activities. The WGCTA[®] is designed to measure critical thinking as a composite of attitudes, knowledge, and skills. The instrument is available in parallel forms A and B and is also available in an abbreviated version (Form S). Form S was used for this study as it is approved for secondary students and can be completed in approximately 45 minutes.

The reliability of the WGCTA[®] had been previously established and was detailed in the test manual. Reliability estimates for Form S of the WGCTA[®] were reported as a Cronbach's alpha coefficient of .81 ($r = .81$) (Watson & Glaser, 1994). According to Watson and Glaser (1994), "the content validity of the WGCTA[®] in classroom and instructional settings may be examined by noting the extent to which the WGCTA[®] measures a sample of the specified objectives of such learning programs. The statewide objectives of public education in Missouri clearly identify the importance of critical thinking skills as evident by the references to analysis, problem solving, and decision making. The construct validity of the WGCTA[®] can be evaluated by noting its relationship to other tests. Watson and Glaser (1994) report significant relationships between the WGCTA and test of general intelligence (*Otis-Lennon Mental Ability Tests*, the *California Test of Mental Maturity*, and the *Wechsler Adult Intelligence Scale Verbal IQ*).

A second data collection instrument was developed by the researcher. This instrument was completed by the agriculture teacher and consisted of demographic information (gender and grade classification) and achievement data. Student achievement was operationally defined as the score on the 7th grade administration of the science portion of the "Missouri Assessment Program" (MAP). The MAP is a standardized assessment system developed to evaluate student proficiency on the state adopted academic standards. The MAP assesses students in communication arts and science in grades 3, 7, and 10. Mathematics and social studies are tested in grades 4, 8, and 11. As part of the larger study, teachers reported the score on the science portion of the MAP as that was the area most related to agriculture. The seventh grade administration was utilized because it was the most recent administration completed by all secondary students in the study.

Findings

Complete data were available for 105 students. Table 1 displays a summary of descriptive characteristics. Approximately two-thirds of the students (66%) were male and approximately one-third (35%) were female. Sophomores represented a majority ($n = 59, 56\%$)

of the sample followed by freshmen (17, 16%), seniors (n = 16, 15%), and juniors (13, 12%). Further data analysis revealed the mean critical thinking score of 21.3 (SD = 4.36). Critical thinking scores ranged from 10 to 33. The mean achievement score was 685.85 (SD = 25.38). Student's achievement scores on the MAP ranged from 610 to 752.

Table 1
Descriptive Characteristics (n = 105)

Characteristic	Frequency	Percent	Mean	S.D.	Min-Max
Gender					
Male	69	66			
Female	36	34			
Grade Classification					
Freshman	17	16			
Sophomore	59	56			
Junior	13	12			
Senior	16	15			
Critical Thinking Score			21.38	4.36	10-33
Achievement Score (MAP)			685.85	25.38	610-752

Achievement scores were collected in raw score form but were reported categorically by achievement level for descriptive purposes (Table 2). Almost half (44%, $n = 46$) of the students in the sample were in the *progressing* category. Thirty two percent ($n = 34$) of the sample was categorized as nearing proficiency. The remainder of the sample consisted of *step 1* ($n = 13$, 12%), *proficient* ($n = 11$, 11%), and *advanced* ($n = 1$, 1%).

Table 2
Achievement Categories of MAP Scores by Treatment Group (n = 105)

Achievement Category	Frequency	Percent
Step 1	13	12.4
Progressing	46	43.8
Nearing Proficiency	34	32.3
Proficient	11	10.5
Advanced	1	0.9
Total	105	100.0

Objective two sought to explore critical thinking scores by categories of gender, grade classification, and achievement level (Table 3). The mean critical thinking score for males was 21.96 compared to a mean for females of 21.78. By grade classification, the lowest critical thinking scores belonged to freshman ($M = 20.24$). Sophomores scored slightly higher followed by juniors. Seniors had the highest critical thinking score. A similar pattern was found in achievement level groups. Students classified as Step 1 had a mean critical thinking score of 19.43. The mean for students in the progressing category had a mean of 20.83. Students in the nearing proficiency category were slightly higher with a mean of 23.06 followed by students in the proficient category ($M = 26.22$). Only one student met the criteria of advanced and subsequently scored a 28 on critical thinking.

Table 3
Mean Critical Thinking Scores by Selected Variable Categories (n=105)

Characteristic	Mean	S.D.	Min-Max
Gender			
Male	21.96	4.58	13-33
Female	21.78	4.40	14-33
Grade Classification			
Freshman	20.24	3.38	17-28
Sophomore	21.78	4.37	13-33
Junior	22.00	3.94	16-28
Senior	24.00	5.44	16-33
Achievement Level			
Step 1	19.43	3.25	15-26
Progressing	20.83	3.45	13-28
Nearing Proficiency	23.06	4.64	16-33
Proficient	26.22	5.67	17-33
Advanced	28.00	*	*

* (n = 1)

A correlation matrix was generated containing the dependent variable of critical thinking, the variable of interest, and the control variables (Table 3). Control variables, and their correlation with the dependent variable, were gender ($r_{pb} = .02$) and grade classification ($r_s = .23$). Achievement level had a moderate, positive correlation ($r = .43$) with critical thinking. The correlation matrix also served as a diagnostic tool for evaluating multicollinearity. According to Pedhazur (1997), collinearity, described as the correlation between independent variables, may have devastating effects on regression statistics. Correlations between independent variables ranged from .19 to .28 and were considered low according to Davis (1971) conventions.

Table 3
Correlation Matrix of Independent and Dependent Variables

Variable	X1	X2	X3	Y
Gender ^a (X1)	1.0	.28	.24	.02
Grade Classification (X2)		1.0	.19	.23
Achievement Level (X3)			1.0	.43
Critical Thinking (Y)				1.0

^a 0 = female; 1 = male

Hierarchical multiple regression was used to determine the amount of unique variance in critical thinking explained by achievement level (Table 4). The model ($F = 9.72, p < .05$) indicated 24% of variance in achievement ($R^2 = .24$) was explained by gender, classification, and critical thinking ability. To isolate the unique contribution of critical thinking abilities, the control variables were entered into the model first. Gender and classification accounted for 7% ($R^2 = .07$) of variance in achievement. The addition of achievement level to the model resulted in a change in R^2 of .18. The change indicates achievement level contributed 18% of the variance in critical thinking ($t = 4.95, p < .05$).

Table 4
Hierarchical Regression of Critical Thinking on Selected Variables

Variable	R Square		<i>b</i>	<i>t</i>	<i>p</i>
	R Square	Change			
Control Variables	.06	.06			
Gender ^a			1.19	2.44	.02
Classification			-0.45	-0.49	.63
Variable of Interest ^b	.24	.18			
Achievement Level			2.19	4.69	.01*

Note. For Model $F = 9.72, p < .05$.

^a0 = female, 1 = male.

^b Adjusted $R^2 = .20$.

* $p < .05$ for individual variables.

Conclusions and Recommendations

In the study, 35% of the students were female and 65% were male. Data from the Missouri Department of Elementary and Secondary Education (DESE, 2005) indicate approximately 30% of students enrolled in secondary agriculture classes for 2003-04 were female and approximately 70% were male. Therefore, it can be concluded that the sample approximates the gender distribution of secondary agriculture students in Missouri. Sophomores, juniors, and seniors made up almost 85% of the sample. While this is uncharacteristic of statewide enrollment figures, it is understandable given the selection criteria for this study. Teachers were included based on their ability to incorporate a specific unit of instruction into one of their courses. The unit most appropriately fit into an Ag Science II or Natural Resources class. Each of these courses is typically regarded as upper level courses.

State reports for 2004 indicated the 40% of students state-wide were performing at or above the *nearing proficiency* level on the MAP. Forty-four percent of the students in this study were classified as *nearing proficiency* or higher. The MAP achievement levels imply that students in agriculture courses are performing at least as well as the state-wide population of students. As education continues to deal with accountability issues, it is reassuring that agriculture students are performing as well as general populations. Future research is necessary to investigate the contributions agriculture programs make toward standardized testing.

Mean scores for critical thinking indicate that some level of critical thinking is present in secondary agriculture students. A lack of comparative information on secondary level critical thinking ability makes interpreting the level inherently more challenging. Students in the study scored considerably lower than normative data for various professions on the same form of the WGCTA (Watson & Glaser, 1996). More information is needed for students at a similar grade level.

Helmstadter (1985) criticized the WGCTA indicating that mean scores tend to progress logically with age. Findings from this study indicated that an increase in grade classification resulted in an increase in critical thinking ability. Upper grade-level students outperformed lower grade-level students on critical thinking. In spite of Helmstadter's concern, Rollins (1990)

study resulted in similar findings using a different measure of critical thinking. It is not clear whether that increase is a result of education or a result of development.

Educators should continue to value the development of critical thinking. As teachers strive to incorporate strategies into their classroom, differences among grade levels should be considered. While findings from this study only indicate that differences may exist between students at different grade levels, additional studies should be conducted to determine the extent to which grade level impacts a student's ability to think critically. Likewise, strategies most effective for developing critical thinking should be identified through future research and employed in agriculture programs.

There exists some disagreement in the literature regarding the influence of gender on critical thinking. Rudd, Baker, and Hoover (2000) described gender as a significant variable in critical thinking disposition. In contrast, current findings indicate males and females are similar in their ability to think critically. This finding is consistent with research on college students (Myers & Dyer, 2004). Possible differences in these findings may be a result in the inconsistent descriptions and measures of critical thinking.

Findings indicate a moderate (Davis, 1971) relationship between achievement level and critical thinking ability. Students categorized as higher academic achievement levels, as defined by the MAP, exhibit higher critical thinking skills than those students categorized as lower achievement levels. This relationship is in agreement with previous studies that have linked measures of academic ability and critical thinking (Cano & Martinez, 1991, Ricketts & Rudd, 2005; Rollins, 1990).

A variety of definitions of critical thinking have been posed. While some call for harmony or unity in our approach to critical thinking, perhaps the partitioning of critical thinking as a construct is more appropriate. Contradictory findings related to critical thinking could be a result of many sub-constructs. The relationship between academic achievement and critical thinking may indicate that efforts to measure critical thinking may be really measuring academic achievement. As definitions are continually refined, our instruments of measurement must be refined as well.

Eighteen percent of the unique variance in critical thinking scores can be attributed to achievement level category. Similarly, Rollins (1990) found that 28% of variance in critical thinking, measured by the Cornell Critical Thinking Test, could be explained by score on the Iowa Test of Education Development (ITED) reading subtest. Both findings support the argument that academic performance is the best-known variable for explaining critical thinking.

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