

## EXAMINING COGNITION LEVELS OF STUDENTS ENROLLED IN A COLLEGE OF AGRICULTURE

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### Abstract

*Thinking is a hallmark to success. Literature suggested that students who attended college "knew" more when they graduated than when they entered as freshmen. However, is "knowing" enough? This study sought to determine the cognitive development on three cognition levels of senior students enrolled in a college of agriculture. A random sample of senior students was selected for the study. The Developing Cognitive Abilities Test (DCAT) was used to assess students' cognitive abilities on three cognition levels that are consistent with the five lower levels of Bloom's taxonomy of cognitive levels. The results suggested that latitude exists for growth in the cognitive development of senior students; that senior students tended to do best, comparatively, on application abilities; that cognitive development by gender was similar; and that for students in the study, certain academic majors tended to do better on the levels of cognition. Recommendations are offered based on the results and for future research.*

Though several years have passed since the concerns about students' lack of ability in critical thinking, higher-order thinking, and problem-solving were leveled against American schools and colleges by the National Commission on Excellence in Education (1983), these concerns still persist. Boyer (1987) indicated that critical thinking at the college level was one of the most essential skills for further education and work. Dale (1978) stated that "for many years we have talked about education in a changing society, but have done little to educate for uncertainty" (p. 37).

Pascarella (1985) suggested that there was substantial and consistent evidence to support the contention that students typically "knew" more when they left college as seniors than when they entered as freshmen. However, are students taught to think? Lochhead and Clements (1979) asserted that "we should be teaching students how to think; instead we are primarily teaching them what to think." (p.1).

The use of thinking skills in problem situations is universally recognized as a prominent

objective for all educational academies. As such, teaching students how to think has been identified as a goal of educators in colleges of agriculture (Miller, 1989; Harl, 1980; Whittington & Newcomb, 1993). Foster and Pikkert (1991) indicated that if students in colleges of agriculture were to be competitive in a world in which technology was changing more and more rapidly, agricultural faculty needed to be able to provide their students the cognitive abilities that would enable them to solve problems, make decisions, and integrate new technology outside the classroom.

Developing cognitive abilities in students enrolled in colleges of agriculture has been advocated by several researchers and educators (Pickford, 1988; Whittington & Newcomb, 1993; Newcomb & Trefz, 1987; Miller, 1990; Newcomb & Whittington, 1990, 1992; Kuhns, 1977; Johnson & Birkenholz, 1990). Unlike physical abilities, cognitive abilities do not remain static across a lifetime (Halpern, 1986). Because cognitive abilities do not remain static, do educators know at what level of cognition students enrolled in colleges of agriculture function?

**Purpose and  
Research Questions**

The purpose of the study was to describe the measures of ability on three cognition levels (basic, application, and critical thinking) of students enrolled in the College of Agriculture at The Ohio State University. The following specific research questions were examined:

1. What were the performance measures on three cognition levels (basic, application, and critical thinking) of students enrolled in the College of Agriculture by gender?
2. What were the performance measures on three cognition levels (basic, application, and critical thinking) of students enrolled in the College of Agriculture by academic major?
3. What were the overall performance measures on three cognition levels (basic, application and critical thinking) of students enrolled in the College of Agriculture?

**Methods/Procedures**

The accessible population for the descriptive study was senior students enrolled in the College of Agriculture at The Ohio State University during the Autumn Quarter, 1992 (N=388). An up-to-date list of seniors was obtained from the college office and served as the frame for the study. A sample of 196 students was randomly drawn from the population of senior students. The sample size (n=196) was determined using Krejcie and Morgan's (1970) table of sample sizes, specifying a 5% margin of error.

The Developing Cognitive Abilities Test (DCAT) (Beggs & Mouw, 1989) was used to assess the cognitive abilities of students on three cognition

levels (basic cognitive abilities, application abilities, and critical thinking abilities) using items on three content areas (verbal, quantitative, and spatial). The three cognition levels (basic, application, and critical thinking) are consistent with the first five cognitive levels of Bloom's taxonomy (Table 1) -- knowledge, comprehension, application, analysis, and synthesis (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). The evaluation level of Bloom's taxonomy was deleted from the general intent of the DCAT.

The DCAT was considered a standardized instrument and has been assessed for content validity and reliability (Wick, 1990). The reliability estimates, expressed as Kuder-Richardso-20 as a measure of internal consistency, were established by the instrument developers on the three cognition levels: basic cognitive abilities, .81; application abilities, .76; critical thinking abilities, .75; and overall, .90 (Wick, 1990).

Data collection began by mailing students a letter of invitation strongly encouraging participation in the study. The letter was structured according to Dillman (1978) and specified four dates and times with two data collection session on each date. The data collection dates were selected with careful attention to avoid students' exam dates, holidays, and weekends. Students were invited to attend one of eight sessions offered. Students were able to indicate their willingness to participate on a self-addressed, stamped postcard. Ten days after the initial mailing, follow-up efforts were conducted via telephone to determine students' willingness to participate in the study. A make-up data collection session was offered to students unable to attend their scheduled session. All data collection sessions were located in the same room.

A total of 47% (n=92) of the students in the sample participated in one of the eight scheduled or

Table 1. Comparison of Bloom's Taxonomy and the Developing Cognitive Abilities Test

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Bloom's Categories	DCAT Levels
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Knowledge Comprehension	Basic Cognitive Abilities
Application	Application Abilities
Analysis Synthesis	Critical Thinking Abilities

one make-up data collection session. Students who did not participate in the study were treated as non-respondents and considered to be non-response error.

Non-response error was controlled by sampling the non-respondents and comparing them with the respondents. A sample of 10% of the non-respondents (n=11) was randomly drawn and statistically compared to the sample of respondents (n=92) on variables of interest as suggested by Miller and Smith (1983). No significant differences ( $p > .05$ ) were found between the sample of non-respondents and respondents. Thus, the non-response data were pooled with the respondent data, yielding a sample size of 103 (53.0%) and allowing generalization to the sample/population (Miller & Smith, 1983).

### Analysis of Data

The data were analyzed using SPSS/PC+. Descriptive statistics such as frequencies, central tendencies, variance, and ranges were used to characterize the data. A t-test statistic was used to determine significant differences between groups. An alpha level of .05 was set a priori.

### Results

The DCAT provided raw scores for the 103 College of Agriculture senior students by gender on

three cognition levels: basic cognitive abilities, application abilities, and critical thinking abilities (Table 2). Additionally, raw scores (arranged from highest to lowest) on the three cognition levels are provided for each of the nine academic majors (Animal Science, Agricultural Economics, Horticulture, Agricultural Education, Food Science, Dairy Science, Agronomy, Agricultural Education, Agricultural Mechanics) in Tables 3, 4, and 5. The overall raw scores for College of Agriculture students on the three cognition levels (basic cognitive abilities, application abilities, and critical thinking abilities) are presented in lower portions of Tables 3, 4, and 5, respectively. The maximum score possible on each of the three cognition levels was 27. Because of gross disproportional group sizes, statistical differences were not calculated among the nine academic majors. Rather, the group statistics reported (Tables 3, 4, and 5) only serve as descriptive data for senior students in those academic majors for which data was gathered.

A gender analysis (Table 2) indicated that male senior students scored a mean raw score of 20.2 on basic cognitive abilities items, with raw scores ranging from 10 to 27. Similarly, female senior students scored a raw mean of 19.4 on basic cognitive items, with scores ranging from 8 to 26. Using a t-test, no significant difference ( $t = -1.02$ ;  $p > .05$ ) was found to exist between the raw mean scores by gender on the basic cognitive abilities.

Table 2. Performance on the Developing Cognitive Abilities Test by Gender (n=103)

Gender

Cognition Level	Male (n=59)			Female (n=44)			t Value
	Mean	SD	Range	Mean	SD	Range	
Basic Cognitive Abilities	20.2	3.43	10 - 27	19.4	3.88	8 - 27	-1.02
Application Abilities	20.9	2.91	14 - 26	19.3	3.34	12 - 25	-2.60*
Critical Thinking Abilities	16.7	3.78	6 - 25	16.9	4.23	6 - 26	.18

Note: Raw scores are based on a maximum possible score of 27; \*p<.05

Raw mean score for males on application abilities items was 20.9, with raw scores ranging from 14 to 26. Likewise, the raw mean score for females on application abilities items was 19.3, with raw scores ranging from 12 to 25. The difference in raw mean scores by gender on application abilities was found to be statistically significant ( $t=-2.60$ ;  $p<.05$ ).

Raw mean score for males on critical thinking abilities items was 16.7, with raw scores ranging from 6 to 25. The raw mean score for females on critical thinking abilities items was 16.9, with individual raw scores ranging from 6 to 26. No significant difference ( $t=.18$ ;  $p>.05$ ) was found to exist between gender raw mean scores on critical thinking abilities.

With regard to academic major, senior students' raw mean score varied on the basic cognitive abilities (Table 3). Senior students majoring in Dairy Science had the highest raw mean score (22.3) on the basic cognitive abilities items, followed by Agricultural Mechanics (21.5); Agricultural Education (20.6); Food Science (20.4); Animal Science (20.4); Agronomy (19.4); Agricultural Communications (19.3); Agricultural Economics (19.1); and Horticulture (18.3). Overall, the raw mean score for senior students on the basic

cognitive abilities items was 19.9, with raw individual scores ranging from 8 to 27.

Senior students varied by academic major on the mean raw score on application abilities items (Table 4): Agricultural Education (22.6); Dairy Science (21.3); Agricultural Mechanics (21.0); Food Science (20.8); Agronomy (20.6); Horticulture (19.9); Animal Science (19.7); Agricultural Economics (19.6); and Agricultural Communications (17.5). The raw mean score for the application abilities items was 20.2, with individual raw scores ranging from 12 to 26. The overall raw score for senior students on the application abilities items was 20.2, with raw individual scores ranging from 12 to 26.

On the highest cognition level - critical thinking abilities (Table 5) as measured by the DCAT, senior students varied by academic major: Agricultural Mechanics (18.5); Agricultural Education (18.1); Animal Science (17.4); Agricultural Economics (16.6); Food Science (16.4); and Agronomy (15.1). The raw mean score for senior students on the critical thinking abilities items was 16.8, with raw individual scores ranging from 6 to 26.

Table 3. Performance on Basic Cognitive Abilities (n=103)

Major	n	Mean	SD	Range
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Dairy Science	7	22.3	2.81	20 - 27
Agricultural Mechanics	2	21.5	.71	21 - 22
Agricultural Education	11	20.6	1.69	17 - 23
Animal Science	27	20.4	2.83	14 - 25
Food Science	8	20.4	5.18	10 - 26
Agronomy	7	19.4	3.74	16 - 26
Agricultural Economics	21	19.1	3.74	13 - 25
Agricultural Communication	4	19.3	7.80	8 - 26
Horticulture	16	18.3	3.72	12 - 24
Overall	103	19.9	3.63	8 - 27

Note: raw scores are based on a maximum possible score of 27.

### Conclusions, Implications and Recommendations

Senior students enrolled in the College of Agriculture at The Ohio State University in the study scored highest on application abilities items when compared to basic cognitive abilities items and critical thinking abilities items. Conversely, senior students scored lowest on critical thinking abilities items when compared to basic cognitive abilities items and applications abilities items.

Converting raw mean scores on the three cognition levels into conventional interpretations (percentage correct), senior students scored an average of 73.7% on basic cognitive abilities items; an average of 74.8% on application abilities items; and an average of 62.2% on critical thinking abilities. No comparable data for a similar group of students were available. However, the results reported herein serve as baseline for future studies of students enrolled in colleges of agriculture. Senior students enrolled in the College of

Agriculture did not differ significantly by gender on performance in two of the three cognition levels (basic cognitive abilities and critical thinking abilities). However, senior students did differ significantly by gender on performance in the application (application abilities) cognition level, yet there appears to be no practical difference.

Converting raw scores to percentages, male senior students scored an average of 74.8% on the basic cognitive abilities; female senior students scored an average of 71.9% on the basic cognitive abilities items. Similarly, male senior students scored an average of 77.4% on application abilities items and female senior students scored an average of 71.5% on the application abilities items. In addition, male senior students scored an average of 61.9% on critical thinking items and female senior students scored an average of 62.6%. Overall, the lack of practical differences in cognitive ability by gender would imply that cognitive development in male and female senior students enrolled in the College of Agriculture was similar.

Table 4. Performance on Application Abilities (n=103)

Major	n	Mean	SD	Range
Agricultural Education	11	22.6	1.92	19 - 25

Dairy Science	7	21.3	2.29	17 - 24
Agricultural Mechanics	2	21.0	2.83	19 - 23
Food Science	8	20.8	4.13	14 - 25
Agronomy	7	20.6	2.64	16 - 23
Horticulture	16	19.9	2.54	17 - 25
Animal Science	27	19.7	2.79	15 - 25
Agricultural Economics	21	19.6	4.06	12 - 26
Agricultural Communication	4	17.5	4.12	13 - 21
Overall	103	20.2	3.19	12 - 26

Note: Raw scores are based on a maximum possible score of 27.

Table 5. Performance on Critical Thinking Abilities (n=103)

Major	n	Mean	SD	Range
Agricultural Mechanics	2	18.5	.71	18 - 19
Agricultural Education	11	18.1	2.94	13 - 22
Animal Science	27	17.4	3.91	6 - 25
Agricultural Economics	21	16.6	4.07	6 - 23
Food Science	8	16.4	6.97	6 - 25
Dairy Science	7	16.4	3.36	12 - 21
Horticulture	16	16.1	3.53	12 - 26
Agricultural Communication	4	16.3	4.27	13 - 22
Agronomy	7	15.1	3.34	9 - 19
Overall	103	16.8	3.96	6 - 26

Note: Raw scores are based on a maximum possible score of 27.

As a group, senior students in the study majoring in Dairy Science scored highest of the nine academic majors on basic cognitive abilities items. Senior students majoring in Agricultural Education scored highest of the nine academic majors on application abilities. Regarding critical

thinking abilities, senior students majoring in Agricultural Mechanics for whom data was gathered scored highest of the nine academic majors.

The intent of the DCAT was to provide an indication of cognitive characteristics that can be altered in the school environment (Beggs & Mouw, 1989). Thus, based on the data, there remains latitude for cognitive growth in senior students.

The latitude for cognitive growth would imply that senior students enrolled in the College of Agriculture are graduating with less than adequate cognitive skills to allow them to solve problems, make decisions, and think critically.

It therefore becomes imperative that instructional intervention to develop higher-order thinking in students be elevated in all courses, beginning with the freshmen level. In developing of higher-order thinking, teaching methods need to be utilized that will advance instructors beyond presenting factual knowledge. Instructors should be educated to develop cognitive skills in students that require them to do more than regurgitate the subject matter presented.

Miller (1989) indicated that instructor discourse for instructors in a College of Agriculture tended to occur primarily at the lower levels of cognition, namely the levels of knowledge and comprehension. Why would instructors tend to teach at lower levels of cognition? Perhaps this is because instructors do not know how to reach the higher levels of cognition in their discourse as Whittington and Newcomb (1993) have suggested.

Instructor discourse should transcend all levels of cognition. For example, instructors should begin discussion by asking general recall questions to assess students' knowledge of fact, then ask higher level cognitive questions requiring abilities beyond the recall of facts. Gall (1970) suggested that follow-up questions to students' responses had a significant impact on student cognitive development.

Tests and assignments presented by instructors should include tasks requiring students to apply abilities in the upper cognition levels. Miller (1989) and Pickford (1988) found a positive association between the cognitive level of tests and assignments, and level of cognitive performance in college students. Additionally, Newcomb and Trefz (1987) and Miller (1989) supported the thesis that when instructors incorporated laboratories, homework, individual group projects, and term papers in the learning process, students were more likely required to use critical thinking abilities than when instructors used only tests, quizzes, or in-class discourse.

To develop appropriate pedagogical skills in instructors that allow for teaching and learning to occur across all cognition levels (particularly at higher levels), workshops should be offered on various instructional interventions such as classroom discourse, examinations or quizzes, and out-of-class assignments that will promote problem solving, decision making, and critical thinking in all students.

These workshops should be designed and implemented by teacher educators in agricultural education with the guidance of the College of Agriculture teaching committee. Earlier studies (Clegg, Farley, & Curran, 1967; Farley & Clegg, 1969) found that instructors asked significantly more questions at higher cognitive levels when they had received instruction in the knowledge and use of Bloom's taxonomy to guide classroom instruction. Additionally, Taba (1966) reported that teachers taught to use Bloom's taxonomy produced in students an increase in the number of higher levels of interaction, a greater number of ideas, and ideas or units of thought that were greater in complexity.

Further research is needed in the cognitive development of students enrolled in colleges of agriculture. This research should investigate students' cognitive ability as entering freshmen and then again as graduating senior students to determine individual gains and gains by academic major. Moreover, representative samples should be drawn from each academic major to determine differences in cognitive ability by academic major. Additionally, research should be conducted to test the stability of the results reported herein. Efforts should be generated to continue this line of inquiry at other colleges of agriculture as well as other colleges within the university system.

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