AN ASSESSMENT OF COGNITIVE ABILITIES OF
PRESERVICE TEACHERS IN AGRICULTURAL EDUCATION

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Introduction

The speed of technological advances and the demands they place on people will require them to function independently. As such, teaching students to think well and think for themselves has not had the same urgency it has today. Many national documents related to education (i.e., A Nation at Risk, 1983; America 2000, 1991; Goals 2000, 1994; Seven Priorities of the USDE, 1997) have espoused the need to develop students who can exercise thinking skills. Most directly targeted to vocational-technical education was the 1991 Secretary's Commission on Achieving Necessary Skills (SCANS) report that argued for the need to direct attention and strengthen students’ abilities in three foundation areas including thinking skills. The other foundations are basic skills and personal qualities. Bloom and his associates (1956) offered perhaps the most convincing reason for developing thinking skills. They indicated that teachers have the task of preparing individuals for challenges that cannot be foreseen. All that can be done under such conditions is to help students acquire intellectual abilities and skills that will serve them well in new situations. Simply put, students must be prepared to respond to questions and problems that await them “around the corner.”

Literature Base

Thinking skills is used herein as an umbrella term for a range of higher-order intellectual powers including critical thinking, reasoning, problem-solving, decision making, and creative thinking (Torres & Cano, 1995). Costa (1997) defined thinking as manner in which an individual
uses intellectual behaviors in response to questions and problems to which they do not immediately know the answer. He added that students must call upon their store of knowledge and experiences as sources of data to support, theories to explain, or processes to solve each new challenge (Costa, 1997).

The literature highlights several variables associated with developing thinking skills. They can be grouped into environmental variables (Perkins, 1995; Ennis, 1985), student-related variables (de Bono, 1993; McKeachie, 1994), and teacher-related variables (Whimbey & Whimbey, 1976; Davis, 1993; McKeachie, 1994; Costa, 1997).

From this literature, perhaps the most pervading influence for developing thinking skills in students is the teacher. Dalzell (1997, p. 5) argued that “teachers who themselves are effective thinkers and who are worthy models to emulate serve their students well.” Baumfield (1997) supported this claim when she stated that the teacher needs to be able to model explicitly for students how to solve problems, make decisions, and reason. Effective teachers model what they espouse, and thinking skills are no exception (Costa, 1997). However, teachers are less likely to teach students to think if they themselves lack the skill (Gibbs, 1997). Consequently these teachers are unable to model the desired thinking behaviors. Given this premise, assessing the thinking skills of teachers is important. Currently, research is lacking in agriculture education in this problem area. Therefore, providing baseline data pertaining to preservice teachers’ thinking skills would be fruitful to agricultural education.

**Purpose and Objectives**

The purpose of the study was to explain and describe agriculture preservice teachers’ cognitive abilities. The objectives for the study were:
1. Describe the characteristics of preservice teachers as to gender, ethnicity, and age.

2. Describe the cognitive ability of preservice teachers across academic content areas.

3. Describe the cognitive ability level of preservice teachers.

**Methods/Procedures**

The study was designed using descriptive survey methods. The target population was preservice teachers enrolled in agricultural education. The accessible population was senior level preservice teachers enrolled in agricultural and extension education at New Mexico State University. A longitudinal study was undertaken using a convenience sample of preservice teachers. Class rosters from a senior level teaching methods course during 1995, 1996, 1997, and 1998 served as the frame for the study. The combined number of preservice teachers was 69.

The *Developing Cognitive Abilities Test* (DCAT) is a timed test and was used to assess the cognitive ability of students in three academic content areas and three cognitive levels (Beggs & Mouw, 1989). The three academic content areas were verbal, quantitative, and spatial skills, each area consisting of 27 items. The three cognitive levels (Basic, Application, and Critical Thinking), each with 27 items, were measured using items in the three academic content areas. In total, there were 81 items. The three cognitive levels were consistent with the first five levels of thinking skills categories of Bloom’s taxonomy for cognition (Table 1): Knowledge, Comprehension, Application, Analysis, and Synthesis (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). The developers deleted the Evaluation level of Bloom’s taxonomy because it did not contribute to the intent of the DCAT (Beggs & Mouw, 1989).
Table 1. Comparison of Bloom’s Taxonomy and the Developing Cognitive Abilities Test

<table>
<thead>
<tr>
<th>Bloom’s Categories</th>
<th>DCAT Levels</th>
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<tbody>
<tr>
<td>Knowledge</td>
<td>Basic Cognitive Ability</td>
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<tr>
<td>Comprehension</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Application Cognitive Ability</td>
</tr>
<tr>
<td>Analysis</td>
<td>Critical Thinking Ability</td>
</tr>
<tr>
<td>Synthesis</td>
<td></td>
</tr>
</tbody>
</table>

The developers established the validity and reliability of the DCAT. The DCAT Technical Manual, authored by Wick (1990), detailed the procedures and criteria for constructing the test and the measures for establishing content validity. The test manual also outlined the reliability estimates for each section of the DCAT. Reliability estimates, expressed as Kuder-Richardson-20 as a measure of internal consistency, for the verbal, quantitative, and spatial content areas were .80, .84, .75, respectively. Additionally reported were reliability estimates for the Basic, Application, and Critical Thinking cognitive levels as .81, .76, .75, respectively. Overall, the reliability estimate for the DCAT was .90 (Wick, 1990). Preservice teacher characteristics data were gathered by accessing student records.

Data were collected during the period preservice teachers were enrolled in the teaching methods course. The senior level course met during the fall semester of each academic year at the same time and in the same location. The DCAT was distributed and administered by the researcher according to the procedures outlined in Directions for Administration booklet provided by the developers. The classroom environment remained the same for each data collection period.
Data were analyzed using SPSS/pc. Frequencies, percent, mean, standard deviation, and range were used to describe the data.

**Results and Conclusions**

Characteristic data is reported in Table 2 profiling the 69 preservice teachers. The majority of preservice teachers were White males. Hispanic preservice teachers represented approximately 23 percent of the respondents, with small percentages represented by African American and American Indian preservice teachers. The age of preservice teachers ranged from 21 to 56 years. The average age was approximately 28 with the majority of preservice teachers falling within seven and a half years of age difference of each other.

Table 2. Characteristics of Preservice Teachers (n=69)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
<th>Percent</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>23</td>
<td>33.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>46</td>
<td>66.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>49</td>
<td>71.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>16</td>
<td>23.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>3</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>1</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>27.9</td>
<td>7.51</td>
<td>21-56</td>
</tr>
</tbody>
</table>

Preservice teachers’ cognitive abilities scores were gathered on three academic content areas (verbal, quantitative, and spatial). The verbal section of the DCAT sought to measure the literal understanding and appropriate use of words and phrases. This section also measured the perception of interrelationships among series of statements by making inference from context or
forming conclusions through propositional reasoning about given information (American Testronics, 1990).

The quantitative section measured the functional understanding of arithmetic operations, basic geometric concepts, and the ability to apply mathematical principles in the solution of story problems. This section also measured the ability to transform given information into new relationships required for the solution of problems (American Testronics, 1990). The third section, spatial content, measured the recognition and retention of object characteristics such as size, shape, symmetry, and pattern. Also measured in the spatial section is the ability to estimate what would occur when one or more objects change in location or position. Furthermore, the spatial section measured the ability to mentally transform objects through imagination of the identification of the parts resulting from dividing an object.

For each of the measured areas, a maximum raw score of 27 (one point per item) was possible. In each of the 27 item content areas, nine were at each of the three cognitive levels (Basic, Application, Critical Thinking). Table 3 provides the results of preservice teachers’ cognitive abilities on the three academic content areas.

Preservice teachers were most successful in the verbal content area of cognitive abilities. Conversely, preservice teachers were most challenged by cognitive abilities in the spatial content area. Individual raw scores for each content area varied as represented by the standard deviations and ranges reported in Table 3.
Cognitive abilities of preservice teachers were assessed at three levels--Basic (Knowledge, Comprehension), Application, and Critical Thinking (Analysis, Synthesis). For each of the cognitive abilities levels, a maximum raw score of 27 (one point per item) was possible. Each cognitive abilities level contained 27 items in the three academic content areas (verbal, quantitative, and spatial). Table 4 presents the results of preservice teachers’ cognitive ability at the three levels of cognition.

As a group, preservice teachers scored relatively equally in each of the three levels of cognition. However, preservice teachers were slightly more competent in application type items, reporting a mean of 18.4. Conversely, preservice teachers were slightly more contested at critical thinking type items, reporting a group mean of 14.9. There was an equal amount of variation in raw score for each of the cognitive levels as indicated by the standard deviation and range scores (Table 4).

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Table 3. Cognitive Ability of Preservice Teachers Across Content Areas (n=69)

<table>
<thead>
<tr>
<th>Academic Content Area*</th>
<th>Mean</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal</td>
<td>20.6</td>
<td>3.54</td>
<td>11-27</td>
</tr>
<tr>
<td>Quantitative</td>
<td>17.0</td>
<td>4.40</td>
<td>5-27</td>
</tr>
<tr>
<td>Spatial</td>
<td>13.1</td>
<td>3.57</td>
<td>6-22</td>
</tr>
</tbody>
</table>

Note. *Maximum possible raw score was 27.
Table 4. Cognitive Ability of Preservice Teachers (n=69)

<table>
<thead>
<tr>
<th>Cognitive Level*</th>
<th>Mean</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>17.4</td>
<td>3.47</td>
<td>7-25</td>
</tr>
<tr>
<td>Application</td>
<td>18.4</td>
<td>3.41</td>
<td>8-26</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>14.9</td>
<td>3.69</td>
<td>6-23</td>
</tr>
</tbody>
</table>

*Maximum possible raw score was 27.

Educational, Scientific, and Practical Importance of the Study

Since the formation of public education, no other student outcome has been more cherished than a student’s ability to reason, solve problems, and think independently. Secondary agricultural education programs have a successful history in promoting the development of these skills and abilities in students. However, student success can be attributed to many dynamic and interrelated factors. For centuries, researchers have investigated a myriad of antecedents that contribute to the development of thinking skills. The teacher is one antecedent few would dispute leads to successful student outcomes.

Research indicates that teacher-related factors such as their philosophical beliefs (Blane, 1969), professional preparation (McMillan, 1987), cognitive expectation (Pickford, 1988), instructional delivery (McKeachie, 1994), and the nature of their tests and assignments (Miller, 1989) leads to the development of higher-order thinking skills in their students. Yet Gibbs (1997) offers a major premise that teachers who do not possess a particular skill themselves are less likely to teach it. Should this premise hold true, teachers’ ability to exercise and promote higher-order thinking will impact students’ ability to develop these thinking skills and abilities themselves.
This study sought to investigate the thinking skills of preservice teachers in agricultural education. Thus far, the data presented herein serve as a benchmark for identifying preservice teachers’ thinking skills and abilities. Yet as one invokes the premise that teachers are more likely to teach skills they, themselves, can perform, the implications of these data are wide and varied.

One implication is that these preservice teachers performed best in verbal skills and, thus, are more likely to contribute to student outcomes in this area relative to quantitative and spatial content areas. These data further imply preservice teachers’ capacity for integrating academic skills into the agricultural curriculum -- an outcome strongly encouraged by education leaders. A second implication gathered from these data suggests that preservice teachers are more likely to emphasize basic and application skills and abilities when teaching students than skills and abilities requiring critical thinking.

These implications affect teacher education. Is it enough to teach preservice teachers how to develop higher-order thinking skills in student if they, themselves, do not possess the capacity to exercise these skills and abilities? What does this mean for preservice teacher program design and instruction? At first glance, it might be recommended that teacher educators in agricultural education reassess the nature and scope of courses required for degree completion. Holding the course instructor constant, do the nature and scope of the prescribed courses provide preservice teachers an opportunity to develop the essential academic and higher-order thinking skills, a trait strongly desired of them as future teachers? Furthermore, while educators such as McKeachie (1994) and others offer suggestions for developing thinking skills, are teacher educators in agricultural education promoting a learning environment that fosters higher-order thinking skills?
These and other questions should be explored in moving toward developing the most cherished of all educational outcomes, higher-order thinking skills.

References


An Assessment of Cognitive Abilities of Preservice Teachers in Agricultural Education

A critique

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As Y2K fears surround us, technology continues to advance at such a pace that even as we learn new techniques or develop new products we know that as soon as they are produced they are obsolete. New and exciting ideas spring from each advancement and leave their parent source in the past. The researcher is to be commended for addressing such a pressing issue as understanding the level of thinking skills among our preservice teachers.

The study was inclusive of four years of preservice teachers at a land grant university. It utilized a tried and reliable instrument to determine cognitive abilities in three academic content areas (verbal, quantitative, and spatial). Based on the precept that the methodology was sound and reliability evident, the researcher’s implications become quite thought provoking. Are we truly preparing our teachers to teach critical thinking skills, or are we simply teaching them to follow a recipe?

If we teach as we are taught, then what can we do to demonstrate critical thinking skills in addition to basic application skills? I would like to commend the researcher for developing a thought provoking benchmark in how we perceive the preparation of our preservice teachers.

I close with an appropriate quote from this study, “teachers who themselves are effective thinkers and who are worthy models to emulate serve their students well.”