AN ASSESSMENT OF FOOD AND FIBER SYSTEMS KNOWLEDGE IN SELECTED OKLAHOMA HIGH SCHOOLS

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Abstract

In 1988, the National Research Council recognized agricultural literacy as a need for every K-12 student. After more than 13 years of agricultural literacy efforts, this criterion group ex-post facto study sought to assess the agricultural literacy of selected program completers (high school seniors) in Oklahoma. An instrument based on the Food and Fiber Systems Literacy (FFSL) Framework was developed to assess the agricultural literacy of students in grades 9-12. Six schools, two in each of three locations (urban, suburban, and rural) were selected for inclusion in the study. Comparisons were made between general education students and agricultural education students, between the three types of schools according to overall mean scores and between the five agricultural themes of the FFSL Framework. Agricultural education students and general education students did not differ in their overall mean agricultural knowledge scores. Students in rural schools, however, obtained lower overall mean agricultural knowledge scores than did students in urban and suburban schools, with rural schools scoring lowest in three of the five thematic areas of agriculture. Given the low agricultural knowledge scores of students overall, it was determined that the program completers who participated in the study were not agriculturally literate.

Introduction

In a democratic society whose people must elect officials to enact policy which will guide the many aspects of their lives, literacy of various forms has been of concern to the American public. The very first law on public education in America, The Code of 1650, (1822) addressed the need for reading literacy among the common people in order to provide the "citizen-run" republic with an informed citizenry. In recent years, an emphasis on cultural literacy (Hirsch, 1987) and political literacy (Osler, 1999) further supported the concept that to hold a participatory role in society a knowledgeable electorate was needed to ensure that legitimate lawmakers are in place and appropriate laws enacted.

The National Research Council (NRC, 1988) indicated that agriculture was also "…too important a topic to be taught only to a relatively small percentage of students" (p. 1). The committee recommended "…all students should receive at least some systematic instruction about agriculture beginning in kindergarten or first grade and continuing through twelfth grade" (p.10).

Fourteen years after the NRC report (1988) first called for efforts in K-12 agricultural literacy, the following questions still needed to be addressed: Are senior high school students, having completed the K-12 public school curriculum, agriculturally literate? Have the literacy efforts in agricultural education been successful?

Theoretical/Conceptual Framework

Laying a foundation for a conceptual model (Figure 1), the Committee on Agricultural Education in Secondary Schools (NRC, 1988) began to develop the idea of "agricultural literacy" and proposed that an agriculturally literate person would understand the food and fiber system in relation to its historical, economic, social, and environmental significance. Later, Frick (1990) reported one of the first conclusive agricultural literacy definitions: "Agricultural literacy can be defined as possessing knowledge and understanding of our food and fiber system... An individual possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture" (p.52).

Nunnery (1996) later proposed the development of a literacy framework for understanding agriculture's perspectives and viewpoints. Leising and Zilbert (1994) approached agricultural literacy from the same angle and developed a systematic curriculum framework identifying what students should know or be able to do. The Food and Fiber Systems Literacy (FFSL) Framework outlined what an agriculturally literate high school graduate should comprehend (Leising, Igo, Heald, Hubert and Yamamoto, 1998). By providing progressive standards in five thematic areas of agriculture, the FFSL framework delineated the necessary components of a theoretical framework for understanding the way food and fiber systems relate to daily life. Breaking the standards into grade-grouped benchmarks (K-1, 2-3, 4-5, 6-8, 9-12), the framework provided a systematic means of addressing agricultural literacy.

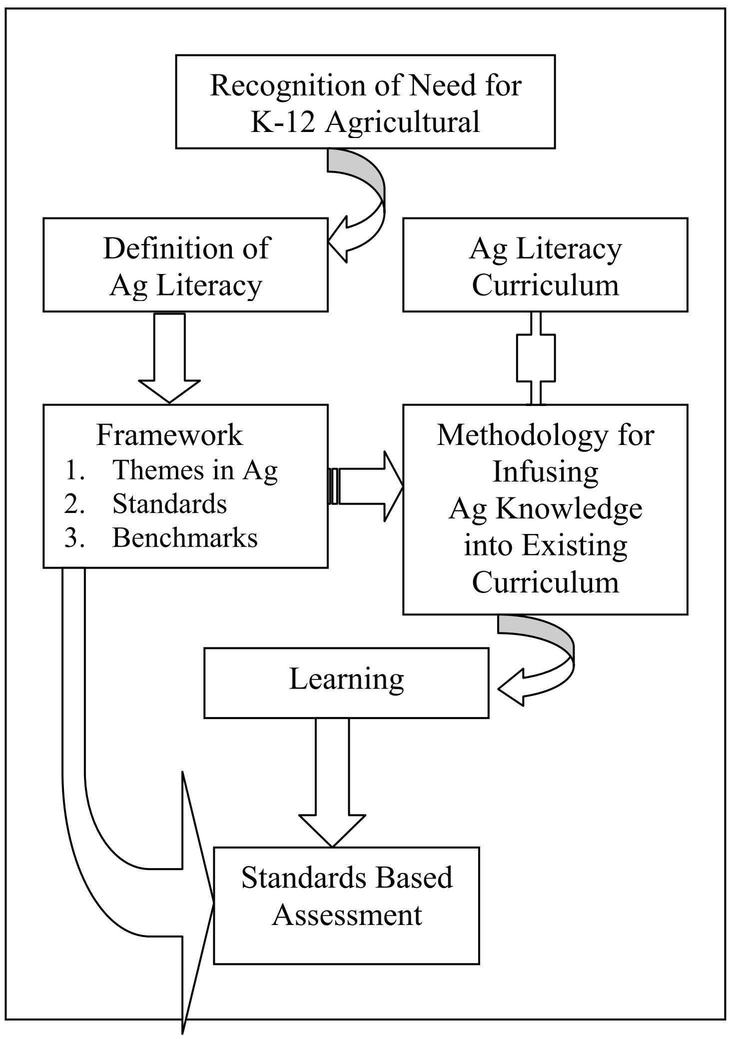

Figure 1. Conceptual Model of the Food & Fiber Systems Literacy Framework role in the development of agricultural literacy curriculum and assessment. (Leising, Pense and Portillo, 2003, p. 4).

Case studies by Igo, Leising and Frick (1999) found that K-8 education about agriculture could be infused into core academic learning. They also found that the FFSL Framework's standards and benchmarks were effective for assessing elementary students' knowledge about agriculture.

This study employed the FFSL Framework standards and benchmarks to develop an instrument for assessing grades 9-12 agricultural literacy. An ex-post facto design was used in assessing the agricultural literacy of 12th grade students in Oklahoma high schools in order to understand whether literacy efforts in agriculture for this population were effective over the course of each student's 12 years in public school.

Purpose and Objectives

The purpose of this study was to assess the food and fiber systems knowledge of twelfth grade students in Oklahoma prior to graduation. The specific objectives were:

1. Assess whether the *General Education student population* and the *Agricultural Education student population* in urban, suburban and rural schools are agriculturally literate in twelfth grade.
2. Determine strengths and weaknesses of agricultural knowledge for the *General Education student population* and the *Agricultural Education student population* using the five thematic areas of food and fiber identified in the FFSL Framework.
3. Compare / contrast *agricultural education students* and *general education students* in urban, suburban and rural schools by agricultural knowledge scores.

Methods and Procedures

The methodology for this study was a criterion group ex post facto research design. This method is appropriate when the variables being studied are not manipulated; but rather, studied as they exist in the situation (Wiersma, 1995). Babbie (1986) stated that ex post facto is appropriate when attempting to determine cause and effect relationships between events that have already occurred. Wiersma (1995) further explains that ex post facto designs are appropriate for attempting to explain relationships and effects occurring between the variables.

Population

To determine similarities and differences, two student groups were studied: students majoring in General Education (defined as those students who had not taken any agricultural education courses) and students majoring in Agricultural Education (those students who had taken three or more semesters of coursework in agricultural education).

The population of the study included agricultural education students and general education students from six high schools in the state of Oklahoma who expected to graduate in spring, 2002 (public school program completers). The population size was 330; approximately fifty five students from each of the six schools. As random sampling was not feasible given the unique characteristics of each school, the availability of subjects in intact groups, and the large number of classes and schools; the study employed a purposive sample (Wiersma, 1995). Worthen, Sanders and Fitzpatrick (1997) employ the term "judgement sampling" (p.359), the strength of which is found in describing a subgroup, thus permitting a better understanding of the program as a whole.

The purposive sample also incorporated a cross-section of senior students in three different types of secondary schools in Oklahoma; urban, suburban and rural. Two schools of each type were selected in order to provide an adequate number of Agricultural Education students in the population. The population included approximately 40 General Education seniors and approximately 15 Agricultural Education seniors at each site. General Education students tested at each type school were as follows: urban – 66, suburban – 74 and rural – 71. Agricultural

Education students included urban – 33, suburban – 56 and rural – 30. Intact groups of students representing diverse academic ability, both genders, and all present ethnicities were selected.

Instrumentation

A review of the literature revealed that there were no instruments based on an agricultural literacy framework that could be used to assess grades 9-12. Therefore, the researcher, in collaboration with others, developed an instrument based on the grades 9-12 benchmarks of the FFSL Framework. Instruments based on the FFSL Framework used to measure student knowledge about agriculture in grades K-8 provided guidance for the instrument development process.

To ensure questions were valid, the researcher employed three methods to generate and validate the test questions used to assess agricultural knowledge. First, each item was referenced to one of five thematic areas of agriculture in the Food and Fiber Systems Literacy Framework, and the grade level grouping 9-12 standards and benchmarks of the Framework. By employing a method of criterion referencing, a "representative sample of items was established from a well defined domain of behavior in order to be valid" (Center for the Study of Evaluation, 1979, p. 10).

Second, a panel of three credentialed Agricultural Education teachers and three graduate students in Agricultural Education, who had no contact with any of the test sites, agreed to serve on the test development panel to write the items. Adkins-Wood (1960) underscores the need for item writers to possess several important qualities to increase content validity, including a thorough knowledge of the subject matter, an intimate understanding of specific teaching objectives, and a facility in the clear and economical use of language.

Third, the questions were validated by a panel of secondary school teachers of various disciplines to ensure that each item addressed its corresponding FFSL benchmark content, the content was grade-level appropriate, and each item was language appropriate. According to the Microsoft Word spelling and grammar check readability ranged from sixth to twelfth grade reading levels.

The instrument underwent considerable revision and was written in a format that would be consistent with a criterion-referenced knowledge achievement test. Gronlund (1998) points out that multiple-choice items are most widely used for measuring knowledge, comprehension and application outcomes. In addition, a broad sample of achievement could be measured, incorrect alternatives could provide diagnostic information, and scoring would be easy, objective and reliable. The test was also scrutinized to ensure that each item was written according to rules established for multiple-choice items (Gronlund, 1998).

Pilot Testing and Item Revision

Two pilot tests were undertaken, the first conducted on May 15, 2001 with 17 senior students in an intact English IV class at Yale Senior High School, a small rural school in Oklahoma. The instrument was then reviewed again a second and third time, deleting or revising questions based upon the input from the students and the indices indicating difficulty and discrimination from an item analysis of the pilot test (Wiersma & Jurs, 1990). The second and final pilot test with twenty senior high school students was conducted in the U.S. Government class at Glencoe High School, also a small rural school in Oklahoma, on September 4, 2001.

Reliability of the Criterion-Referenced Test

Acknowledging that the instrument was criterion-referenced with five thematic areas in agriculture and that the instrument was less homogenous, a reliability coefficient of 0.846 was computed for the first pilot test using the Kuder/Richardson-20 (KR-20) Method, while the second and final pilot test yielded a reliability coefficient of .933 (Table 1).

While a computed estimate of the reliability is deemed by some as better estimates of the test's adequacy than a researcher's subjective impressions, there is clear disagreement in the literature as to whether reliability coefficients should be computed for criterion-referenced tests. Wiersma and Jurs (1990) provide eight general factors through which a researcher

Table 1
Reliability Coefficients and Indices of Difficulty and Discrimination for Each of the Two Pilot Tests

Test Site	Reliability	Difficulty	Discrimination
Yale H.S.	0.846	72.511	0.200
Glencoe H.S.	0.933	58.200	0.325

may enhance the reliability of an instrument and the researchers sought to address each of the following during instrument development: homogeneous items, discriminating items, enough items, high-quality copying and format, clear directions to the student, a controlled setting, motivating introduction, and clear directions to the scorer.

Data Collection

In order to obtain the broadest cross-section of students in Oklahoma, test sites were selected according to three geographic locations (urban – a city with a population of 90,000 or more; suburban – a community adjacent to an urban area; and rural – a town with a population of 5,000 or less, and/or a town with a school district with less than 2500 students). Two schools in each location were purposively selected for study, giving a total of six study sites. The two urban schools were selected from the same school district because of access constraints in the other urban areas of Oklahoma. Since each school differed in organization and scheduling, administrators were asked to select intact classes that would give the best cross section of students according to academic ability, gender and race. In addition, a census of all twelfth grade Agricultural Education students at each site was included.

The completed instrument was administered at each test site by the same researcher. Each instrument was numbered in an effort to keep scores separate and school identity clear, but care was taken not to identify individual students with their corresponding test number; thus ensuring anonymity. Prior to each testing session, an introduction to the study was given and test instructions read to the respondents. Each student worked quietly and independently, marking answers on a general purpose NCS® answer sheet.

Profile data on the schools used in the research study was obtained through the assistance of school administrators. Demographic information of each school was based on copies of documents the schools submit for state and federal funding and qualitative observations made by the researcher. Student demographic information was obtained from students in a ten item questionnaire attached at the end of the testing instrument.

Testing time required by students ranged from 25 to 50 minutes. It was assumed that respondents would provide honest expressions of their knowledge. Therefore, it was determined that incomplete exams and those exams completed in less than ten minutes would not be included in the sample as they were not deemed to be "honest expressions" of the students' knowledge. By so doing, skewed results were less likely to occur.

Analysis of Data

The answer sheets were scanned and entered into an SPSS® 8.0 version data file. In cases where marks on the answer sheets were not readable by the scanning machine, corrections were entered by hand to assure completeness and accuracy of the data.

Descriptive statistics were used to report frequencies, percentages, means and standard deviations as calculated by SPSS® version 8.0. Inferential statistics (One-way ANOVA) were employed as a guide to understand the relationships between and among variables. Analysis of variance (ANOVA) procedures, including the General Linear Models procedure, was performed using SPSS® version 8.0. The three assumptions required for an ANOVA design were met establishing *independence* through the unrelated scores obtained in the study's overall design, *normality* implied by employing a large sample (population), and *homogeneity of variance* shown through a Levene Test that established equal sized groups and ensuring homogeneity was equally spread across the groups (Keppel, 1991). A Tukey's Post-hoc strategy was employed to make pair-wise comparisons in order to understand where the groups differ. Eta squared (η^2) was calculated to ascertain the practical significance of the test.

Results and Findings

Table 2 summarizes the frequencies, means, standard deviations, and mean percentage scores of student agricultural knowledge by school type. Table 2 also provides overall aggregate mean scores of all the students participating in the study. Student mean agricultural knowledge scores for each school type were below 50 percent. Students in rural schools scored lower than their urban and suburban counterparts; nearly eight percentage points lower than suburban students and over 5 percentage points lower than urban students.

Table 2
Summary of Selected Oklahoma High School 12th Grade Students' Mean Agricultural Knowledge Scores by School Type and Total Aggregate Mean Scores

School type	N	Mean	S.D.	Mean %	S.D.
Urban	99	23.40	7.45	46.81	14.90
Suburban	130	24.58	7.38	49.15	14.76
Rural	101	20.69	6.32	41.39	12.64
Total	330	23.07	7.25	46.13	14.50

A series of Two-way ANOVA (2x3 designs) procedures were run for each of the five agricultural themes of the FFSL Framework to determine whether differences existed between mean agricultural knowledge scores of agricultural education and general education students, and differences between the students at the three types of schools included in the study. A significant difference (p = .021) between the mean agricultural knowledge scores of agricultural education students and general education students existed only in theme four, Business & Economics (Table 3), where agricultural education students' mean percentage score was more than six points higher than that of general education students (Tables 3 and 4).

Student mean agricultural knowledge scores differed significantly among school type (Table 3) in the following themes: Theme 2 – History, Culture, & Geography (p = .004); Theme 3 – Science & Environment (p = .010); Theme 4 – Business & Economics (p = .004); and Theme 5 - Food, Nutrition & Health (p = .031). Only Theme 1, Understanding Agriculture, showed no significant differences among type of students or type of schools (Table 3).

Table 3
Analyses of Variance Between Selected Oklahoma 12th Grade Agricultural Education and General Education Students' Mean Agricultural Knowledge Scores by Agricultural Theme and School Type

Source and Themes 1-5	df	F	p	η^2	Power
(1) Understanding Agriculture					
Student Major (S)	1	.815	.367	.003	.147
School Type (T)	2	2.142	.119	.013	.438
T x S	2	.846	.430	.005	
Error	321	(329.060)			
(2) History, Geography & Culture					
Student Major (S)	1	.004	.950	.000	.050
School Type (T)	2	5.547	.004*	.033	.852
T x S	2	.551	.577	.003	
Error	321	(548.326)			
(3) Science & Environment					
Student Major (S)	1	.986	.322	.003	.168
School Type (T)	2	4.677	.010*	.028	.783
T x S	2	.051	.950	.000	
Error	321	(383.385)			
(4) Business & Economics					
Student Major (S)	1	5.391	.021*	.017	.639
School Type (T)	2	5.654	.004*	.034	.859
T x S	2	.103	.902	.001	
Error	321	(435.136)			
(5) Food, Nutrition & Health					
Student Major (S)	1	.603	.438	.002	.121
School Type (T)	2	3.513	.031*	.021	.653
T x S	2	.906	.405	.006	
Error	321	(307.743)			

Table 4
Summary of Oklahoma 12th Grade Agricultural Education & General Education Students' Mean Percent Agricultural Knowledge Scores by Agricultural Theme, Total Aggregate Scores and Type Student

	Ag. Ed.			Gen. Ed.		
Agricultural Themes 1-5		Mean	SD	N	Mean	SD
(1) Understanding Agriculture	119	52.99	17.23	211	50.78	18.83
(2) History, Geography & Culture	119	49.23	23.82	211	48.67	23.88
(3) Science & Environment	119	47.47	21.56	211	44.46	18.72
(4) Business & Economics	119	45.91_a	22.65	211	39.66_b	20.36
(5) Food, Nutrition & Health	119	43.28	20.87	211	40.52	15.56

Note. Means in the same row that do not share the same subscript differ at p < .05 calculated using ANOVA procedures.

Two degrees of freedom existed for the School Type variable in each of Themes 2 - 5 and a Tukey HSD post hoc analysis was conducted. Results of the post hoc test were summarized in Table 5. Themes 2 - 5 did not differ significantly between students attending urban and suburban schools, but differences did exist in Themes 2, 3 and 4 between students attending urban and rural schools, and students attending suburban and rural schools (Table 5). In each of the three themes, the mean agricultural knowledge scores of rural schools were significantly lower than the urban or suburban mean scores, registering an 11 percentage point spread between urban and rural schools in Theme 4, and a nearly 12 percentage point difference between suburban and rural schools in Theme 2. Although the ANOVA test indicated significant difference in Theme 5, the post hoc results indicated no significant differences between the three types of schools (Table 5).

Table 5
Composite Summary of Oklahoma 12th Grade Agricultural Education & General Education Students' Mean Agricultural Knowledge Percent Scores by Agricultural Theme and School Type

	Urban		Suburban		Rural	
Agricultural Themes 1-5	Mean	D	Mean	D	Mean	D
(1) Undstding. Agriculture	52.58	19.47	53.99	17.56	47.45	17.46
(2) Hist., Geog., & Culture	50.62_a	25.61	53.31_a	23.01	41.40_b	21.42
(3) Science & Environment	46.67_a	21.06	48.81_a	20.32	40.18_b	16.71
(4) Business & Economics	46.69_a	20.36	43.41_a	21.15	35.29_b	21.24
(5) Food, Nutrition & Health	39.46	16.33	44.55	20.53	39.55	14.12

Note. Means in the same row that do not share the same subscript differ at p < .05 in the Tukey HSD post hoc analysis.

Conclusions

The conclusions in this study were not to be generalized beyond the 330 selected twelfth grade students of the six Oklahoma high schools who participated in this study. The major findings presented in the study support the following conclusions:

1. Both Agricultural Education students and General Education students, regardless of school type, possessed some agricultural knowledge.
2. Agricultural Education students did not differ from General Education students in their level of overall knowledge about agriculture.
3. Students enrolled in rural schools were less knowledgeable about agriculture than students attending urban or suburban schools.
4. Student agricultural knowledge scores differed significantly according to school type in three of the Food and Fiber Systems Literacy Framework themes: History, Culture & Geography; Science & Environment; and Business & Economics.
5. All students in the study possessed similar levels of knowledge for the theme, Understanding Agriculture; a foundational subject area of the Food and Fiber Systems Literacy Curriculum Framework.
6. Students attending rural schools possessed lower levels of agricultural knowledge than those in urban or suburban schools on three of the FFSL themes: History, Culture, & Geography; Science & Environment; and Business & Economics.
7. The overall agricultural knowledge of 12th grade students at the six Oklahoma high schools that participated in this study did not demonstrate that they were agriculturally literate, as defined by the FFSL Framework. This lack of agricultural literacy was demonstrated by overall mean agricultural knowledge scores, for each school type, at or below 49.15%.

Recommendations

Based upon the conclusions and major findings of this research, the following recommendations were made:

1. The instrument developed in this study based upon the Food and Fiber Systems Literacy standards and benchmarks for grades 9-12 should be used by teachers and curriculum specialists in order to identify where gaps exist in student knowledge about agriculture.
2. The current agricultural education curriculum for students preparing for careers in agriculture may assume students enrolled will also become agriculturally literate. Results of this study suggest that further study of the agricultural education career preparation curriculum should be conducted.
3. Further research is warranted in order to understand why rural students were deficient in three of the five Food and Fiber Systems Literacy thematic areas.
4. Urban and suburban students scored similarly in most themes and higher overall than their rural counterparts. Further study is needed to understand what commonalties exist in urban and suburban curricula that might facilitate acquisition of agricultural knowledge and better guide curriculum development.
5. Overall low agricultural knowledge scores indicated that students participating in the study were not agriculturally literate. In an already overloaded curriculum, materials need to be developed for every discipline that will integrate applicable agricultural concepts at both the elementary and secondary school levels and build on existing instructional activities.

Implications

Based on the conclusions from this study, agricultural education programs across the nation may be too narrow in scope. There exists a need to review agricultural education curriculum and programs, teacher preparation programs, and uses of cooperative extension. With the right modifications, it may be possible to develop agricultural education programs that not only give students a career skill, but a broader understanding of agriculture and its impact on society. And perhaps, students who have completed agricultural education programs will, themselves, become a reservoir of agricultural knowledge for others.

Agricultural educators, industry, and extension educators may also help expand the agricultural knowledge of educators in other disciplines, resulting in greater use of agriculture as a context for teaching other subject matter. This may contribute to increased agricultural literacy among all K-12 students. Given time, this may extend agricultural literacy to the adult population - an electorate that should be well informed when it selects those who determine state and national policy in agriculture.

Agricultural literacy has been studied for nearly 15 years. During this time, programs and curriculum have been designed to promote agricultural literacy for grades K-8. And yet, this study revealed that students who have just completed 12 years of schooling through the current system have failed to become agriculturally literate. It is time for agricultural literacy programs and materials to be scrutinized – diagnostic tools, like this instrument based on themes, standards and benchmarks, need to be employed to evaluate and modify the methods, materials and strategies that are currently being utilized.

Further discussion among agricultural educators and agricultural literacy specialists is clearly needed to better understand societal needs for agricultural literacy. An opportunity exists for continued discussion on how best to infuse agricultural knowledge into the overloaded, compartmentalized educational system in high schools and how standards and benchmarks can be used to advantage in assessing agricultural literacy levels.

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