Journal of Agricultural Education
Volume 46, Number 3, pp. 107-118
DOI: 10.5032/jae.2005.03107

COMPARATIVE ASSESSMENT OF STUDENT AGRICULTURAL LITERACY IN SELECTED AGRICULTURE IN THE CLASSROOM PROGRAMS

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Abstract

The purpose of this quasi-experimental study was to assess change in student agricultural knowledge after implementing Agriculture in the Classroom (AITC) programs and to identify strengths and weaknesses of student knowledge according to the five thematic areas of the Food and Fiber Systems Literacy (FFSL) Framework. The experimental group was comprised of selected classrooms (K-6) with AITC trained teachers in Arizona, Montana, Oklahoma and Utah. The control group was comprised of selected classrooms (K-6) in the same four states with teachers who had no exposure to AITC. Pre-test and posttest mean score comparisons by grade groupings and in the five thematic areas of the FFSL Framework resulted in greater agricultural knowledge gains in all four grade groupings by the AITC treatment group over the control group. The study concluded that AITC training of teachers made a positive difference in student acquisition of knowledge about agriculture.

Introduction

America's food and fiber systems determine the nations' general welfare and standard of living. Ten years ago, Leising and Zilbert (1994) recognized that nearly ninety percent of the population was two or three generations removed from direct contact with food and fiber production, while Portillo and Leising (2003) cited year 2000 statistics indicating employment in farming, fishing and forestry represented only 1% of the total employment by occupational grouping in the United States.

Goal three within the national strategic plan for Agricultural Education encourages all students to be conversationally literate in agriculture, food, fiber and natural resources systems (National Council for Agricultural Education, 2000). The objectives for that goal include verbiage promoting integration of agricultural concepts within all subject areas and all grade levels. Knobloch and Martin (2002) underscored the need for agricultural awareness while linking the philosophical basis for agricultural literacy to Dewey's early philosophy on experiential learning.

According to the National Research Council (1988) all students, beginning in kindergarten and continuing through twelfth grade, should receive agricultural literacy instruction. One program designed to address this need was Agriculture in the Classroom (AITC), formalized by the United States Department of Agriculture (USDA) in 1981. In 1982, *The Model State Action Plan* was disseminated by the USDA for organizing and implementing AITC programs. These programs were set up in every state and traditionally organized through state departments of agriculture

and/or organizations such as Farm Bureau (Traxler, 1990).

Since 1982, many states have developed AITC program goals and objectives. For example, Illinois' state AITC goals were to:

> "(a) provide for a systematic infusion of agricultural concepts into the basic subject areas of the curriculum, and (b) to provide in-service training to teachers of the basic subject areas in order to provide necessary background information for incorporation of agricultural knowledge into their respective subject areas" (Law, 1990, p. 6).

To accomplish such goals, state AITC programs developed instructional materials and held teacher-training workshops, but few conducted on-going assessments to determine what agricultural knowledge students were learning. Therefore, baseline data were needed to ascertain what students were learning about agriculture from AITC trained teachers. Such findings could provide key indicators of progress being made toward the achievement of program goals. By identifying where gaps in student knowledge of agriculture occur, program leaders would be better able to focus efforts in instructional material development and teacher training.

Theoretical Framework

Laying a foundation for a conceptual model (Figure 1), the Committee on Agricultural Education in Secondary Schools 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 history, economic, social, and environmental significance (NRC, 1988). Later, Frick (1990) reported one of the first conclusive agricultural literacy definitions: "Agricultural literacy can be defined as possessing knowledge and understanding of the food and fiber system… An individual possessing such knowledge would be able to synthesize, analyze, and communicate basic information about agriculture" (p. 52). Testing for a student's knowledge about the food and fiber system addresses not merely understanding but plays a role in every category of the cognitive domain (Weirsma & Jurs, 1990). Testing knowledge in the many themes and related standards of agriculture, then, should reflect both understanding and the ability to "synthesize, analyze, and communicate basic information about agriculture" (Frick, p. 52). Leising and Zilbert (1994) developed a systematic curriculum framework identifying five themes of what students should comprehend, synthesize and communicate about agriculture.

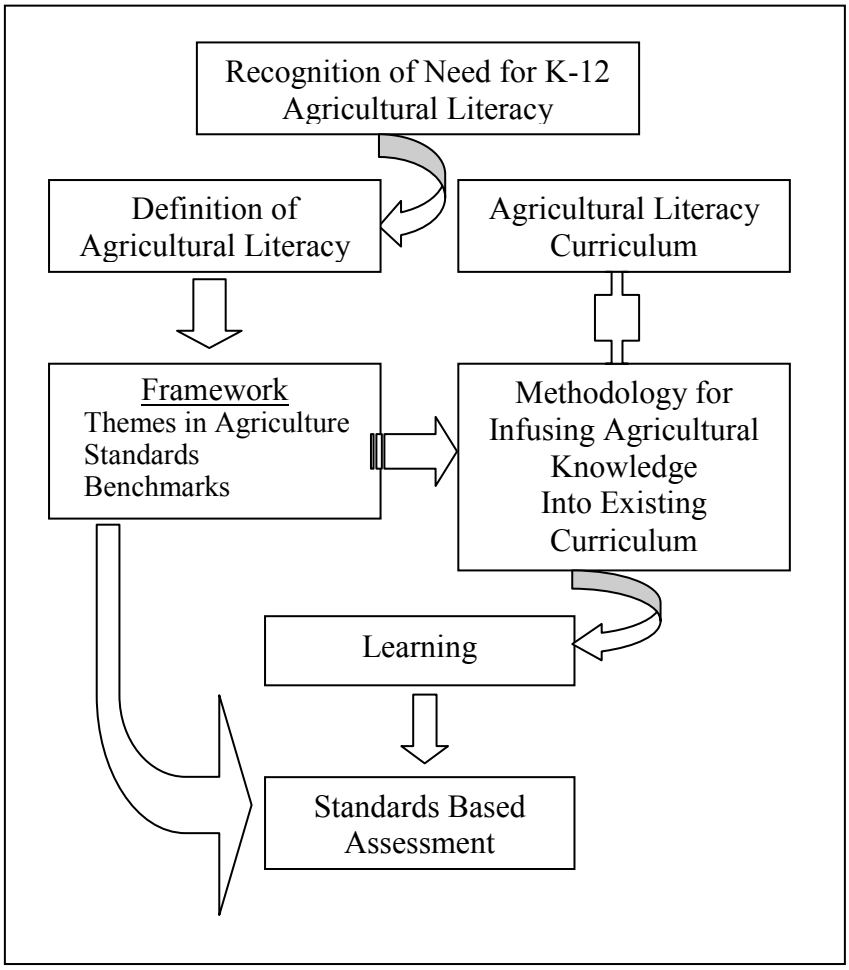

Figure 1. Conceptual Model of the Food & Fiber Systems Literacy Framework's Role in the Development of Agricultural Literacy (Leising, Pense, & Portillo, 2003, p. 4)

With the identification of agriculture's five themes, and each theme's complementary concepts (standards), the FFSL Framework addressed the multiple concepts of Caine and Caine's Brain-Based Theory (1994). Balshweid (2002) stated, "…Brain-Based Theory and the Experiential Learning Theory [Dewey, 1938] suggest that the interface between context and content provides students with multiple opportunities for transfer and overlap of complementary concepts" (p. 57). Organizing the standards into grade-grouped benchmarks (K-1, 2-3, 4-5, 6-8, 9-12), the framework provided a systematic means of addressing these overlapping complementary concepts in agricultural literacy.

Agricultural Literacy Assessment

Igo (l998) studied three schools (K-8) using the FFSL Framework for infusing agriculture into the core curriculum. He reported it was possible to use the standards and grade-grouped benchmarks to infuse instruction about agriculture and increase student knowledge of agriculture. He also reported strong relationships between student agricultural knowledge gains and the number of instructional connections teachers made to the FFSL Framework.

Meischen and Trexler (2002) conducted a qualitative study in which seven fifth-grade rural students were interviewed. Based on two frameworks, Benchmarks for Science Literacy (American Association for

the Advancement of Science, 1993) and the Food and Fiber Systems Literacy Framework (Leising, Igo, Heald, Hubert & Yamamoto, 1998), they determined student understanding and the ability to converse about meat and livestock were incomplete.

The USDA conducted an evaluation of the AITC program in 1988 at the National AITC Conference in Las Vegas by surveying each state director (USDA, 1988). In addition to identifying strengths and successes of the AITC program, survey respondents called for guidelines that would direct the development and evaluation of educational materials. Their report stressed the need to conduct national and state evaluations of AITC's impact on K-12 students.

Purposes and Objectives

The purpose of this study was to determine whether AITC programs resulted in higher student achievement of agricultural knowledge within selected intact kindergarten through sixth grade public school classrooms in which the teacher had received organized and systematic AITC training. The specific objectives of the study were:

1. Compare control and treatment differences by grade grouping (K-1, 2-3, 4-5, 6) in overall student knowledge about agriculture, before and after instruction, based on the grade-level benchmarks of the FFSL Framework.
2. Compare control and treatment differences by grade grouping in the five thematic areas of student knowledge about agriculture, before and after instruction, using the standards and grade-level benchmarks for each of the five thematic areas of the FFSL Framework.
3. Develop a profile of student knowledge about agriculture, before and after instruction, for each grade grouping.

Methods and Procedures

Based on a Grounded Theory Approach (Wiersma, 1995), this study built on prior learning theories (Caine & Caine, 1994; Dewey, 1938), studies which developed and refined an agricultural literacy framework for students in grades K-12 (Leising & Zilbert, 1994; Leising, et al., 1998), and studies which tested the use of a curricular framework in agricultural literacy (Leising, Pense, & Igo, 2001). Those studies concluded the FFSL Framework could be used for infusing agricultural knowledge into existing curriculum and assessing student knowledge about agriculture.

This study was a quasi-experimental nonequivalent control group design, using a pre-test and posttest, as described by Campbell and Stanley (l963). The treatment group was comprised of selected intact classrooms (K-6) with Agriculture in the Classroom (AITC) trained teachers. The control group was comprised of selected intact classrooms (K-6) with teachers who had received no systematic or organized instruction about agriculture.

A project external advisory committee of state AITC coordinators and United States Department of Agriculture AITC staff recommended states with strong AITC programs for participation in the study, and four of the recommended states agreed to participate: Arizona, Montana, Oklahoma and Utah. Project staff collaborated with AITC coordinators in the four states to select the classrooms for inclusion in the study.

The population for this study included 52 treatment classrooms and 48 control classrooms (1,734 students). The target population was based on 7 grade levels (K-6) with 2 classrooms at each grade level in 4 states, with an expected 56 schools in each of the control and treatment groups. However, as testing began on the same day as the national tragedy of September 11, 2001, ten teachers opted not to continue with the testing of their students. This resulted in 52 treatment and 48 control classrooms participating in the study.

Instrumentation

To control for internal validity of existing knowledge of food and fiber systems, and to determine similarity, students in the treatment and control groups were administered the same pre-test at the beginning of the school year. The pre-test and posttest instruments, the Food and Fiber Systems Literacy Tests, were the same (Leising et al., 2001).

To account for all topics comprising agricultural literacy, instruments based on a comprehensive framework were identified; the Food and Fiber Systems Literacy tests were the only instruments found in the literature to meet this requirement. External validity was first addressed by employing the criterion referenced tests developed from the FFSL Framework, a framework developed in California by Leising & Zilbert (1994) and further refined in Oklahoma (Leising, et al., 1998). Both studies used a rigorous application of a modified Delphi Method and were completed over a period of three years by agricultural and education experts in several states to identify Themes, Standards and grade-level Benchmarks which would address curriculum and assessment of K-12 student knowledge about agriculture.

Four instruments were developed based on the grade-level groupings in the FFSL Framework: K-1, 2-3, 4-5, and 6. To ensure questions were valid, the researcher referenced each item to one or more of the five thematic areas of agriculture in the FFSL Framework, and conformed to the appropriate grade grouped benchmark. 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).

To further ensure validity, the instruments went through a series of developmental stages. First, a pool of test items was generated by the project advisory committee, curriculum specialists at Montana State University and Oklahoma State University, and elementary and middle school teachers at project test sites (Igo, 1998). Each item was reviewed by curriculum specialists and elementary teachers for age level, reading level, and vocabulary level appropriateness as called for by Adkins-Wood (1960) who underscored the need for item writers to possess a thorough knowledge of the subject matter, an intimate understanding of specific teaching objectives, and facility in the clear and economical use of language in test construction. Further review of test items by researchers and curriculum specialists ensured the test items adhered to the appropriate grade-level benchmark.

The K-1 and 2-3 instruments included 16 and 21 items respectively. Both primarily used a format consisting of questions to be read by the teacher followed by a series of illustrations from which the students were to select the correct answer or answers. The K-1 instrument responses were entirely pictures, while the 2-3 instrument used picture and simple text responses.

The 4-5 and 6 grade-level instruments contained 35 and 30 text-responses respectively. While multiple choice, true/false and matching items were employed for the K-1 and 2-3 instruments, only multiple choice items were used for those students in the 4-5 and 6 grade-level groupings. Gronlund (1998) pointed out multiple-choice items were most widely used for measuring knowledge, comprehension and application outcomes. The instruments underwent considerable revision and were written in a format that would be consistent with a criterion-referenced knowledge achievement test. The test was also scrutinized to ensure each item was written according to rules established for multiple-choice items (Gronlund).

As an added measure of reliability, 35 Montana State University elementary education majors pilot tested the instruments, followed by further item analysis and revision. A final pilot test was conducted with an elementary student population in a Montana school. Acknowledging the instruments were criterion-referenced with five thematic areas in agriculture and that the instruments were less homogenous, a Guttman Split-Halves reliability coefficient was computed for each instrument using the Statistical Package for Social Sciences (SPSS) version 8.0 software, resulting in reliability coefficients of 0.78 for the K-1 instrument, 0.95 for

the 2-3 instrument, 0.79 for the 4-5 instrument and 0.79 for the grade 6 instrument.

Computed estimates of reliability were deemed by some as better measures of test adequacy than a researcher's subjective impressions, however there was clear disagreement in the literature as to whether reliability coefficients should be computed for criterion-referenced tests. Wiersma and Jurs (1990) provided eight general factors through which a researcher may enhance the reliability of an instrument and the researchers sought to address each factor during instrument development: homogeneous items, discriminating items, enough items, high-quality copying and formatting, clear directions to the student, a controlled setting, a motivating introduction, and clear directions to the scorer.

Treatment and Control Groups

The treatment group consisted of intact classrooms in which the teachers had received organized education about agriculture from their state Agriculture in the Classroom programs. The classrooms were purposively selected by each state's AITC coordinator because the teachers had demonstrated success in integrating agriculture into core subjects after receiving inservice training and/or curricular materials from their state AITC program.

The control group consisted of classrooms in the same four states from which the treatment group was taken. Criteria for selecting the two classrooms in each state for each of the seven grade levels in the control group included geographic location, size of schools similar to the treatment group, and no AITC training or integration of agriculture by the classroom teacher.

Prior agricultural experience and prior knowledge of the teachers was measured for treatment and control groups and no differences were found (Portillo & Leising, 2003). In addition, the validity threat to selection of subjects was addressed by having the AITC director from each state purposively select control and treatment schools to ensure similarity of geographic, economic, and school demographic characteristics for each participating site. External validity was addressed by pre-testing students in the control and treatment schools to determine whether the subjects in each group possessed similar agricultural knowledge prior to the study. Assuming low turnover rates in teachers at each school, similar prior knowledge in the treatment and control groups would indicate that neither group of teachers had a proclivity to teach or not teach agriculture prior to AITC training. The authors also acknowledged that other intervening variables inherent to intact groups purposively selected may exist with the population under study.

Data Collection

The student pre-test was administered to the treatment and control groups during September/October 2001 and prior to any teaching about agriculture. Teachers at the test sites administered posttests in March/April 2002 only to those students who had been pre-tested. The time between pre- and posttests addressed the interaction threat to external validity, while an instrumentation threat was addressed when project staff prepared directions/procedures for collecting the data from each site and trained the AITC coordinators in methods for administering the instruments to teachers and students. Completed instruments were collected by the AITC coordinators and returned to the researchers by mail.

Data Analysis

Upon completion of pre-testing, tests were scored and coded into a Microsoft™ Excel spreadsheet for analysis. The posttest data were coded in the same manner following the administration and retrieval of those instruments, and SAS version 8.2 was used to perform all statistical procedures analyzing data for both pre-tests and posttests in conjunction with the purpose and objectives of the study. Mean percentages were computed by grade-level grouping for the test scores from both groups.

Findings

Data in Tables 1 and 2 summarized grade groupings for *AITC* treatment and control groups by pre-test and posttest mean

percent scores and mean percent score differences. The pre-test mean percent scores of the treatment and control groups were similar indicating no difference in knowledge about agriculture at each grade grouping. Posttest mean percent scores for the treatment group were higher than the posttest mean percent scores of the control group. Each of the four grade levels in the treatment group had a higher overall gain (difference) in agricultural knowledge than students in the control group.

Table 1
Summary of Grade Groupings for AITC Treatment Group by Pre-test and Posttest Mean Percent Scores and Mean Percent Score Differences

Grade	Pre-test			Posttest			
Grouping	*N*	*M (%)*	*SD*	*N*	*M (%)*	*SD*	Diff
K-1	264	53.64	12.44	248	67.31	9.78	13.67
2-3	311	73.08	13.25	284	84.55	15.03	11.47
4-5	295	54.84	12.16	277	68.00	15.47	13.16
6	128	48.16	11.47	107	66.59	21.78	18.43

Note: Mean score (*M*) reported as percentage. Difference (Diff) was calculated as posttest minus pre-test.

Table 2
Summary of Grade Groupings for AITC Control Group by Pre-test and Posttest Mean Percent Scores and Mean Percent Score Differences

Grade	Pre-test			Posttest			
Grouping	*N*	*M (%)*	*SD*	*N*	*M (%)*	*SD*	Diff
K-1	246	51.36	13.00	178	58.26	12.73	6.90
2-3	290	74.39	12.84	226	78.77	15.90	4.38
4-5	321	51.50	13.44	283	56.86	13.82	5.36
6	149	47.23	11.74	129	50.98	11.32	3.75

Note: Difference (Diff) was calculated as posttest minus pre-test.

Grade 6 of the treatment group demonstrated the largest pre-posttest gain (difference) in mean scores (Tables 1 and 2), while grade 6 in the control group showed the smallest pre- posttest gain (difference) in mean scores. The 2-3 grade grouping had the smallest increase of pre-posttest agricultural knowledge scores among the four grade groupings of the treatment group. All pre- posttest score increases for the control group at each grade grouping were less than 7 percentage points. Two of the grade groupings had less than a 5-point increase in pre- posttest scores.

Tables 3 and 4 provide a summary of mean scores and comparisons of the pre-test and posttest score gains by grade groupings within theme areas for the treatment group and control group. The AITC treatment group experienced much greater knowledge gain scores than did the control group in each of the five thematic areas for each of the four grade groupings. It was interesting to note that of the treatment group's four grade groupings, the sixth grade posttest exhibited lower overall scores (Table 3) while their knowledge *gains* from pre-test to posttest were much greater than the other grade groupings in three of the FFSL thematic areas: Theme 1 –Understanding Agriculture, Theme 3 – Science & Environment, and Theme 4 – Business & Economics. Only in the K-1 grade grouping were the largest gains observed for Theme 2 – History, Geography & Culture; and Theme 5 – Food, Nutrition & Health.

Table 3
Summary of Pre- Posttest Mean Percent Scores of AITC Trained Treatment Group by Grade Grouping Within FFSL Theme Areas

Theme & Grade Grouping	Pre-test			Posttest			
	N	*M (%)*	*SD*	*N*	*M (%)*	*SD*	Diff
I. Understanding Agriculture							
K-1	264	67.42	20.14	248	82.76	17.95	15.34
2-3	311	70.33	16.50	284	83.52	12.50	13.19
4-5	295	60.03	14.89	277	71.97	14.41	11.94
6	128	45.00	14.19	107	63.77	28.19	18.77
II. History, Geography & Culture							
K-1	264	56.00	25.50	248	81.37	21.05	25.37
2-3	311	57.00	13.87	284	74.59	20.82	17.59
4-5	295	42.62	19.75	277	62.97	23.45	20.35
6	128	55.00	20.41	107	78.93	30.09	23.93
III. Science, Technology & Environment							
K-1	264	73.69	18.30	248	87.28	13.92	13.59
2-3	311	63.32	17.08	284	72.17	16.88	8.85
4-5	295	64.16	22.83	277	72.80	23.72	8.64
6	128	39.62	25.25	107	66.47	12.06	26.85
IV. Business & Economics							
K-1	264	72.66	21.55	248	82.93	18.55	10.27
2-3	311	60.85	17.85	284	68.23	18.62	7.38
4-5	295	48.84	19.89	277	61.12	21.73	12.28
6	128	50.25	18.25	107	70.93	24.45	20.68
V. Food, Nutrition, & Health							
K-1	264	76.50	19.62	248	91.46	12.68	14.96
2-3	311	62.18	17.18	284	66.02	20.22	3.84
4-5	295	35.38	22.22	277	40.53	22.38	5.15
6	128	44.33	18.38	107	55.40	19.50	11.07

Note: Difference (Diff) was calculated as posttest minus pre-test.

Table 4
Summary of Pre- Posttest Mean Percent Scores of AITC Non-trained Control Group by Grade Grouping within FFSL Theme Areas

	Pre-test			Posttest			
Theme & Grade Grouping	*N*	*M (%)*	*SD*	*N*	*M (%)*	*SD*	Diff
I. Understanding Agriculture							
K-1	246	61.80	21.38	178	70.71	18.23	8.91
2-3	290	71.66	16.33	226	78.38	13.53	6.72
4-5	321	58.00	14.89	283	63.69	15.89	5.69
6	149	43.23	13.34	129	43.59	12.46	0.36
II. History, Geography & Culture							
K-1	246	57.05	25.75	178	66.32	26.15	9.27
2-3	290	56.94	17.70	226	62.94	18.47	6.00
4-5	321	37.25	19.25	283	43.43	21.91	6.18
6	149	53.68	22.27	129	57.61	20.68	3.93
III. Science, Technology & Environment							
K-1	246	69.84	19.61	178	77.53	18.76	7.69
2-3	290	65.88	14.24	226	69.24	16.28	3.36
4-5	321	56.05	22.83	283	65.21	22.44	9.16
6	149	39.75	23.31	129	49.71	26.31	9.96
IV. Business & Economics							
K-1	246	71.22	19.33	178	77.53	21.44	6.31
2-3	290	61.47	15.47	226	63.32	20.71	1.85
4-5	321	46.94	20.47	283	50.86	20.05	3.92
6	149	47.90	19.80	129	54.88	20.50	6.98
V. Food, Nutrition, & Health							
K-1	246	71.81	20.50	178	81.85	17.43	10.04
2-3	290	62.81	13.72	226	63.40	21.72	0.59
4-5	321	34.33	25.00	283	37.24	26.16	2.91
6	149	43.46	19.38	129	44.70	19.05	1.24

Note: Difference (Diff) was calculated as posttest minus pre-test.

The treatment and control groups in all grade groupings showed little difference in the pre-test scores. In the posttest scores for both treatment and control groups, the K-1 grade group was most knowledgeable about Theme 5 - Food, Nutrition, & Health, while the other three grade groupings scored low or lowest in that theme.

The 2-3 treatment group was most knowledgeable in the posttest about Theme 1 - Understanding Agriculture, followed by Theme 2 - History, Geography, & Culture. They were least knowledgeable about Theme 5 - Food, Nutrition, & Health, followed by Theme 4 - Business & Economics. The 2-3 control group was most knowledgeable about Theme 1 - Understanding Agriculture, and least knowledgeable about Theme 2 - History, Geography, & Culture.

The 4-5 treatment group was most knowledgeable in the posttest about Theme 3 - Science, Technology, and Environment, followed by Theme 1 - Understanding Agriculture. They were least knowledgeable in the posttest about Theme 5 - Food, Nutrition, & Health. The 4-5 control group was most knowledgeable in the posttest about Theme 3 - Science, Technology, & Environment and least knowledgeable about Theme 5 - Food, Nutrition, & Health.

The sixth grade treatment group was most knowledgeable in the posttest about Theme 2 - History, Geography, & Culture, followed by Theme 4 - Business & Economics and was least knowledgeable about Theme 5 - Food, Nutrition, & Health. The sixth grade control group was most knowledgeable in the posttest about Theme 2 - History, Geography, & Culture and least knowledgeable about Theme 1 - Understanding Agriculture.

Conclusions

The conclusions were not to be generalized beyond the population within this research study. Examination and analysis of the major findings for each objective led to the following conclusions:

1. AITC programs made a positive difference in student acquisition of knowledge about agriculture.
2. Students in AITC programs acquired knowledge in all five themes.
3. Different themes appeared to have been successfully taught at different grade levels while developing and implementing agriculturally related lessons. This conclusion supports the conclusions drawn from previous studies (Igo, 1998; Leising, et al., 2001).
4. Teachers at lower elementary school grades (K-3) appeared to make more agricultural connections in their teaching as evidenced by general overall agricultural knowledge scores; an indication that teachers in grades 4-6 may not have been infusing agricultural concepts into the curriculum as often as their colleagues in the lower grades. However, when efforts were made to introduce instructional materials about agriculture to teachers in the upper grades of elementary school, teachers were able to make relevant connections to agriculture with their students, as evidenced by greater *gain* scores by 4-6 grade students in the AITC treatment group.

Implications and Recommendations

1. It is recommended that AITC coordinators in the four states participating in the study put more training emphasis on Themes 3, 4 & 5 (Science, Technology & Environment; Business & Economics and Food, Nutrition, & Health) for the K-1 and 2-3 grade groupings. Additionally, AITC coordinators in these states should put more training emphasis on FFSL Theme 2 – History, Geography & Culture, Theme 4 – Business & Economics and Theme 5 – Food, Nutrition & Health for the 4-5 grade grouping and more emphasis on Theme 1 – Understanding Agriculture and Theme 5 – Food, Nutrition & Health for the 6th grade grouping.
2. A curriculum model, such as the FFSL Framework, should be fully

implemented to ensure students in each grade level are making systematic progress in agricultural literacy.

3. Further research should be conducted to determine if similar knowledge gaps exist in other state's AITC programs and to understand the differences that exist among AITC teacher training programs across the United States.

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