Journal of Agricultural Education, 55(4), 53-71.
doi: 10.5032/jae.2014.04053

Determining the Science, Agriculture and Natural Resource, and Youth Leadership Outcomes for Students Participating in an Innovative Middle School Agriscience Program

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Abstract

The Memorial Middle School Agricultural Extension and Education Center (MMSAEEC) located in Las Vegas, New Mexico is a youth science center focusing on agriculture and natural resources. The purpose of this quasi-experimental study of the MMSAEEC teaching and learning model was to determine if differences exist in science achievement, agriculture and natural resource achievement (ANR), leadership skill development, and interests in agriculture and natural resource and other STEM careers between students who participated in the MMSAEEC program and students at a comparison middle school. Results indicate higher overall standardized science test scores and higher scores in the scientific investigations, physical science, earth science, and science and people sub-dimensions of the science test for MMSAEEC students. MMSAEEC students also scored higher on two of the four sub-dimensions of the ANR test (agriscience and ecology). MMSAEEC students were similar to comparison school students in leadership development and career interests. Based on these results, the MMSAEEC model is a viable model for encouraging science and agriculture and natural resource achievement in middle school programs. Improvements are necessary to enhance overall achievement in ANR including higher scores on emerging ANR issues, leadership development, and interests in agricultural and natural resource careers for program participants.

Keywords: Agriscience, middle School, Agriculture and Natural Resources, leadership Skills, agriculture careers, science integration

On January 26, 2011, the *Wall Street Journal* shared the results from the 2009 National Assessment of Educational Progress. This report found that less than one-third of elementary and high school students have a solid understanding of science concepts (Banchero, 2011). According to the National Research Council's National Science Education Standards, learning science can be complex because science often requires students be taught science concepts as part of an active process. Engaging higher level thinking skills, experiential learning, and scientific-based inquiry are essential to helping science become concrete in the minds of students (Center for Science, Mathematics, and Engineering Education, 1996).

When looking at the integration of agricultural science and hands-on learning in science and technology coursework, one important question has been what impact these programs have on middle school educational practices and engagement. To date, most of the secondary education

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research conducted on the impacts of integrating agriculture with science has been limited to high school students and programs. For example, Balschweid (2002) studied the perceptions of high school students enrolled in a biology course that utilized animal agriculture as the context for teaching science. He found more than 90% of the students believed that taking the course helped them understand the relationship between science and agriculture. Students' performance on an agricultural knowledge test administered after they completed the integrated biology course was variable. Students performed best on animal agriculture and poorest on the general agricultural industry questions on the test. In a study of Oregon high school agriculture and science teachers, Thompson and Warnick (2007) found the majority of agriculture and science teachers believed integrating science into agriculture classes helped students learn science concepts and perform better on standardized tests though this was truer for agriculture than science teachers. High percentages of both science and agriculture teachers believed students learn more about agriculture when science is integrated into the curriculum.

Several secondary education studies have employed quasi-experimental and causal comparative research designs to determine the impacts of integrating agriculture with science. Roegge and Russell (1990) found high school students who were taught applied biology as part of the agricultural education curriculum achieved higher scores in applied biology than students taught without it and students also had a more positive attitude toward their learning experience than those taught through the traditional approach. In Louisiana, Chiasson & Burnett (2001) found students who were enrolled in agriscience courses achieved higher scores than non-agriscience students on the science portion of the state-mandated eleventh grade Graduate Exit Examination (GEE) within four of the five science domain subscales (scientific method, biology, earth science, and physics). A statistically significantly higher proportion of agriscience students passed the science portion of the GEE than did non-agriscience students.

According to *Transforming Agricultural Education for a Changing World*, undergraduate colleges must transform the way that they reach students in order to better serve the needs of the learners of tomorrow (National Academy of Sciences, 2009). Agricultural education programs are often charged with providing opportunities for students to pursue agricultural careers (Phipps & Osborne, 1988). In Employment Opportunities for College Graduates, a report published by the USDA, 27% of the future career opportunities from 2010 - 2015 will be in the science and engineering field amounting to a predicted 14,600 annual job openings (Goecker, Smith, Smith & Goetz, 2010). It is, therefore, critical that agricultural education programs be prepared to generate agricultural career interest, help students develop the skills needed for them to be successful in an agricultural career or in an agricultural major, and to eventually help support a growing population.

In addition to improving science achievement, agricultural and natural resource achievement, and career awareness, the opportunity to develop leadership skills is an important part of preparing middle school youth for the future. A study conducted by Rosch and Coers (2013), suggests agricultural educators can effectively support students by providing opportunities for leadership development, especially programs with social-cultural contexts and reflection. Studies within agricultural education have emphasized the need for leadership skills development to be emphasized with agricultural education coursework (Allen, Ricketts, & Priest, 2007; Connors & Swan, 2006; Park & Dyer, 2005; Simonsen & Birkenholz, 2010). McKinley, Birkenholz and Stewart (2010) emphasized this point in their 1993 study by stating "Effective leadership skills have been judged as necessary for success in the complex and rapidly changing agricultural industry" (p. 76).

To address the need for experiential learning, technical skills, high quality programming and leadership development, the Memorial Middle School Agricultural Extension and Education Center (MMSAEEC) was created as a youth science center that focuses on agriculture and natural resources (Skelton & Seevers, 2010). The program was modeled after the New Mexico State University (NMSU) outstate agricultural and natural resource science centers (Skelton & Dappen, 2008). The MMSAEEC was established in 2005 as a partnership between the New Mexico

Cooperative Extension Service and Las Vegas Schools in New Mexico. The purpose of the Center is to develop a sixth through eighth grade teaching and learning model of excellence for agricultural and natural resource science. This model is designed to complement academic subjects by incorporating agriscience through the application of inquiry-based learning and experiential education opportunities (Skelton, Seevers, Dormody, & Hodnett, 2012). The MMSAEEC addresses this purpose through greenhouse experiments, a land lab for ecological studies, field trips, and demonstrations of alternative energy systems and conservation practices. Currently, the primary areas addressed by the Center are agriscience, ecology, issues in natural resource science, and the scientific method. It was anticipated that this model would create an environment that will allow for enhanced learning of basic and agricultural and natural resource sciences, and youth leadership life skills. The program was also designed to enhance interests in science, technology, engineering, and math (STEM) careers including those in agriculture and natural resources.

The MMSAEEC model partners NMSU with a public school to improve learning outcomes as an innovative agricultural education program model. It is essential that the impacts of this model on student learning in science, agriculture, and youth leadership life skills be researched before attempting to diffuse and implement the model at other middle schools in New Mexico and the United States. This research extends the knowledge base on the impacts of integrating STEM and agriculture into middle school curricula. Despite a promising job outlook in science and agriculture, there is a shortage of individuals prepared for STEM integration, incorporating scientific principles, and applying innovation in agriculture (Doerfert, 2011).

Learning theory has been explored by numerous authors (Bandura, 1977; Bloom, 1956; Dale, 1969) to better understand cognitive development and steps in the learning process. Experiential learning is the process whereby knowledge is created through the transformation of experience (Kolb, 1984). Experiential learning creates the necessary learning environment to conduct investigations in real-world contexts in which scientific phenomena occur. Learning in a context provides students with the opportunity to grasp facts, concepts and relationships. Scientific learning grounded in contexts bridges knowledge and experiences students bring to investigations (Cervetti, Pearson, Bravo & Barber, 2006). Important components of effective youth engagement include: involving students in decision making through active exploration of a topic; inquiry-based learning designed to meet student needs; developing collegial relationships with adult partners and mentors; and reflecting on their work and learning skills related to it (Swinehart, 1992). Engaging youth through carefully planned educational activities and hands-on projects enhances learning outcomes (Bourdeau, 2004; Skelton & Dormody, 2009).

Based on these theoretical underpinnings, the operational teaching and learning model for the MMSAEEC that is being tested in this study (see Figure 1) depicts the overlapping interaction between content, context, and engagement (Skelton & Seevers, 2010). Content is guided by grade specific New Mexico public education standards and benchmarks. Context is guided by the mission of the MMSAEEC to deliver programs in agriculture and natural resource science. Content and context are enhanced through the engagement of students using a traditional classroom setting, a laboratory, a greenhouse, the campus landscape, and educational sites located in the diverse Rocky Mountain/Great Plains ecotone.

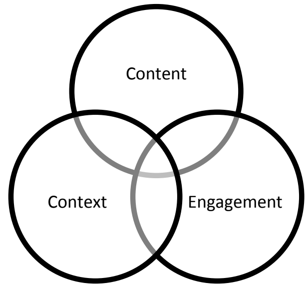

Figure 1. The overlapping interaction of content, context and engagement.

Purpose and Objectives

This research sought to determine the impact of the MMSAEEC on student learning in science, agriculture, and youth leadership life skills; as well as attempting to understand student interests in STEM related careers. The purpose of this study was to examine the suitability of the MMSAEEC model for diffusion to and implementation in other middle school programs. The objectives of the study were to:

1. Determine if differences exist in science achievement scores, agriculture and natural resources achievement scores, and youth leadership life skills development improvement scores between eighth grade students at the MMSAEEC and those at a comparison middle school.
2. Determine if relationships exist between youth leadership life skills development improvement scores and science achievement scores, and youth leadership life skills development improvement scores and agriculture and natural resource achievement scores for 8th grade students at the MMSAEEC and those at a comparison middle school.
3. Determine if differences exist in career interests between students completing eighth grade at the treatment and comparison middle school and, more specifically, their interests in STEM related careers.

Methods and Procedures

Research Design

The study employed a control group design (Campbell & Stanley, 1963) to test objectives one and three of the treatment and comparison middle school students. Objective two was addressed with a correlational design for the samples of eighth graders at both schools. This quasi-experimental research design is relatively free from sources of internal and external invalidity. The greatest threat to internal validity for this design is possible differences in intrasession history between the students at the treatment and comparison middle schools during the school year. Utilizing two middle schools from Las Vegas, New Mexico was an attempt to minimize differences in history between students at the two schools. The researchers did find one difference worth noting. Due to a seventh grade teacher at the treatment school who decided not to integrate the MMSAEEC program activities into lessons, one-half of the students at the treatment school received only two of three years of the treatment.

Population, Sampling, and Treatment

The population for the study was eighth grade students at the treatment school and at a comparison middle school in Las Vegas, New Mexico during the 2009-2010 school year. The population was described in terms of ethnicity, English proficiency, learning disabilities, socio-economic status, and gender. The samples for this study were comprised of the eighth grade students at both the treatment and comparison middle school who turned in both consent and assent forms and completed the necessary instruments. Although the samples were not randomly selected, they were representative of the population on gender, ethnicity, students with disabilities, students living in poverty, and students with Limited English Proficiency (LEP). All students at the treatment school were provided with science instruction that was integrated with agriculture and leadership skills. Classroom instruction was supplemented with the MMSAEEC program activities. Comparison school students were provided similar science instruction without formal integration of these topics. The primary independent variable in the study was being subjected to the treatment or comparison middle school science programs described above. The dependent variables in this study were standardized science test scores, agriculture and natural resource test scores, career interests, and youth leadership life skill development improvement scores.

Instrumentation and Data Collection

Standardized science test score data were collected from the treatment and comparison school administrators. New Mexico has standardized tests in science for both seventh and eighth grade that are aligned with state science content and performance standards (New Mexico Public Education Department, 2005) that measure "adequate yearly progress for each student, public school, and school district" (Legislature of the State of New Mexico, 2003, p. 26). The test consisted of five subtests: scientific investigations, physical science, life science, earth science, and science and people.

An agriculture and natural resource test (ANR) was administered by the researchers at each school at the end of the eighth grade school year to obtain test score data and determine career interests. The science test consisted of four subtests: agriscience, ecology, emerging issues, and scientific method. The researchers developed a valid and reliable instrument based on the state agriculture, food, and natural resource content and performance standards as identified by Castillo (2003) taught through the MMSAEEC during the years students were participating in the program. To develop the ANR, 51 multiple choice questions were written by the Director of the MMSAEEC to represent the standards and benchmarks covered through center activities across the sixth, seventh, and eighth grades in the content areas of scientific method, emerging issues, ecology, and agriscience. Content and face validity of the original test and its 51 items were then assessed by a panel of experts. To establish the reliability of the test, it was then field tested using a two-week test-retest procedure with 55 eighth graders who were not part of this study. An item analysis was conducted on the test and retest data from the 55 eighth grade students in the field test. The item analysis included evaluating consistency in answers between the two test administrations using percent agreement, Kappa scores, and Kappa range. The item analysis also looked at percent of students who answered each question correctly on the test and retest. The idea was to keep a set questions that students answered relatively consistently between the test and retest and that ranged in difficulty, but still maintained content validity (representing the four content areas). Using these item analysis decision tools, 27 questions were eliminated and 25 remained including nine scientific method, three emerging issues, four ecology, and nine agriscience questions. There were six easy items, nine moderately difficult items and 10 difficult items in the final set. These 25 items yielded split-halves reliability coefficients for the pretest and posttest of 0.74 and 0.80, respectively.

The Youth Leadership Life Skills Development Scale (YLLSDS) was administered by the researchers at each school at the end of the eighth grade school year. The YLLSDS (Dormody, Seevers, & Clason, 1993; Seevers, Dormody, & Clason, 1995) is a valid, reliable, and unidimensional 30-question self-rated summative scale that can be utilized in research and evaluation of youth leadership development programs. Rohs (1999) recommended that the YLLSDS be administered twice at the end of a leadership development program. In the first administration, youth reflect on their skill levels at the end of the program (posttest), and in the second administration they reflect back to the start of the program. Studies by Dormody and Seevers (1994) and Seevers and Dormody (1994) have shown a relationship between youth participation in FFA and 4-H programs and YLLSDS scores among Arizona, Colorado, and New Mexico youth. A Cronbach's alpha reliability coefficient of 0.92 was established for the instrument in the pilot test.

Demographic data were provided by school administrators including: ethnicity, LEP status (determined diagnostically by the school district), students with disabilities (who have an Individualized Education Program [IEP]), students living in poverty (qualify for the free or reduced lunch program), and gender. Demographic variables served as secondary independent or control variables. Public schools in New Mexico were required to disaggregate scores on standardized grade-level academic tests by all of these demographic variables except gender for accountability purposes as required by New Mexico public education law (Legislature of the State of New Mexico, 2003) and the No Child Left Behind Act of 2001 (USDE, 2001).

Data Analysis

All data were analyzed using SAS version 9.3 software (SAS Institute, 2010). Differences in science test scores and ANR test scores (including the subscales for both instruments), and YLLSDS after and before differences (or improvement scores), were analyzed using a two factor ANOVA with factors of school and gender. The outlier strategy (Ramsey & Schafer, 2002) was employed with outliers identified as corresponding to observations with standardized residual magnitudes greater than 2.5. Using this strategy, each response variable was analyzed using all data and with outliers excluded. If the analysis with outliers excluded produced substantively different conclusions, then both analyses were reported; otherwise, only the analysis using all data was reported. Because the primary hypotheses were directional, two-tailed p-values were reported. Significance was defined for $p \leq 0.10$. Effect sizes were calculated to make comparisons across the study using the same index of effect. The effect size was calculated using the difference between the post-test means in the numerator of the equation and using standard deviation units in the denominator (Durlack, 2009).

Pearson's correlation coefficients were calculated and assessed for strength (Davis, 1971) and significance ($p < .10$) to determine if relationships existed between youth leadership life skills development improvement scores and science achievement scores, and youth leadership life skills development improvement scores and agriculture and natural resource achievement scores for eighth grade students at the MMSAEEC and those at a comparison middle school. Frequency counts and percent distributions of careers within each sample were calculated on agriculture and natural resource, STEM, and non-STEM career choices for eighth grader comparison between the two schools. The two sample distributions were compared using a Pearson chi-square test.

Results

Informed consent and assent forms were obtained from 91 students at the treatment school (N = 133) and 37 students at the comparison school (N = 89); (see Table 1). It was found that 89% of students at the treatment school and 92% of students at the comparison school were Hispanic. The researchers were unable to reconcile differences in categories of data from the two schools on students with limited English proficiency. A small minority of the students were found to have disabilities, 8.8% at the treatment school and 8.1% at the comparison school. All students at the comparison school qualified for free or reduced lunch (a constant), while only 56% qualified for free or reduced lunch at the treatment school. Although demographic characteristics were initially considered for statistical analysis, only gender had adequate variance at both schools and no categorical problems to be included in analysis with 50.1% of students at the treatment school and 43.2% of students at the comparison school being female.

Table 1

Student demographic characteristics at the treatment school and the comparison school

Characteristic	Treatment school *n* = 91 % (*f*)	Comparison school *n* = 37 % (*f*)
Hispanic ethnicity	89.01 (81)	91.89 (34)
Students with limited English proficiency	---	---
Students with disabilities	8.79 (8)	8.11 (3)
Students living in poverty	56.04 (51)	100 (37)
Gender (female)	50.55 (46)	43.24 (16)

The mean science test score for the treatment school was higher than the mean for the comparison school for science total (p = 0.01), scientific investigations (p = 0.03), physical science (p = 0.01), and science and people (p = 0.07); (see Table 2). Analysis using all available data (n = 127) suggested a difference for Earth Science (p = 0.10; 4.5 vs. 3.8) but reanalysis removing two data points corresponding to high magnitude residuals did not produce a significant school difference (p = 0.1617; 4.39 vs. 3.8). A medium treatment effect size was observed for science total (0.53), scientific investigations (0.43), and physical science (0.67). A small treatment effect size was observed for science and people (0.36). A significant gender main effect was found for scientific investigations (p = 0.09) with females having higher means than males. Medium treatment effect sizes were observed for both females (0.56) and males (0.49). There were no significant effects in gender by school interactions.

The mean ANR test scores for the treatment school were significantly higher than the mean for comparison school for agriscience (p = 0.10) and ecology (p = 0.08) (see Table 3). Small effect sizes were observed for agriscience (0.33) and ecology (0.35), although there was a moderate negative effect size for emerging issues (-0.47) indicating that the comparison group performed better than the treatment group. There were no significant main effects related to gender. Significant main effects were found for gender by school interactions for ANR total (p = 0.08) and emerging issues (p = 0.01). The ANR total for the treatment school males was higher than for the comparison school males (p = 0.05) while the difference between females was not significant (p = 0.56). However, females from the treatment school scored significantly lower than females from the comparison school (p = 0.00) on emerging issues.

The mean youth leadership life skill development improvement scores were not significantly different between the treatment and comparison schools (see Table 4). The negative overall effect size (-0.17) indicates that the comparison group performed better than the treatment group but the magnitude was small. However, a medium negative effect size was found for females (-0.48).

Correlations were calculated to describe the relationships between YLLSD improvement scores and science achievement scores for students at the treatment and comparison schools, as a measure of self-image related to performance (see Table 5). A significant positive relationship between YLLSD and the subdimension of the science standardized test science and people (p = 0.06) was found. However, the magnitude of the correlation coefficient for science and people (r = 0.17) was negligible to moderately weak.

Correlations were calculated to describe the relationships between YLLSD improvement scores and science achievement scores for students at the treatment and comparison schools, as a measure of self-image related to performance (Table 6). Significant positive relationship between YLLSD and the subdimension of the ANR total (p = 0.05) and ecology (p = 0.08) was found. However, the magnitude of the correlation coefficients for ANR total (r = 0.18) and ecology (r = 0.16) was negligible to moderately weak.

Although students at the comparison school were more than twice as likely to be interested in agricultural careers (28.57%) than students at the treatment school (13.25%), the difference was not significant (see Table 7). Students at both schools had strong interests in STEM careers. The chi square distributions for career interest at the two school were not found to be different (p = 0.1506).

Table 2

Mean state mandated science achievement scores between treatment school and comparison school; group effects size; and main effects of gender, school, and the interaction between gender and school.

Variable	Gender	Treatment school *M (SD)*	Comparison school *M (SD)*	Effect size	*p* (F Value)[#] Gender	*p* (F Value)[#] School	*p* (F Value)[#] Gender x School
Science total	All	34.91	29.32	0.53	0.82 (0.05)	0.01*** (7.13)	0.85 (0.04)
	F	34.87 (10.84)	28.88 (9.13)	0.56			
	M	34.96 (10.75)	29.76 (11.07)	0.49			
Scientific investigations	All	9.54	8.23	0.43	0.09* (2.84)	0.03** (4.84)	0.50 (0.46)
	F	9.84 (2.70)	8.94 (3.47)	0.30			
	M	9.24 (3.06)	7.52 (3.31)	0.57			
Physical science	All	8.64	6.65	0.67	0.31 (1.02)	0.01*** (11.75)	0.31 (1.02)
	F	8.64 (3.16)	6.06 (1.91)	0.87			
	M	8.64 (3.16)	7.24 (2.70)	0.48			
Life science	All	8.64	7.59	0.31	0.37 (0.81)	0.11 (2.53)	0.81 (0.06)
	F	8.27 (3.55)	7.38 (3.16)	0.26			
	M	9.02 (3.14)	7.81 (3.56)	0.36			

Table 2 Continues

Table 2 Continued

Variable	Gender	Treatment school *M (SD)*	Comparison school *M (SD)*	Effect size	*p* (F Value)[#] Gender	School	Gender x School
Earth science	All	4.53	3.80	0.33	0.86 (0.03)	0.10* (2.75)	0.67 (0.18)
	F	4.67 (2.64)	3.75 (1.77)	0.41			
	M	4.40 (2.04)	3.86 (2.01)	0.24			
Science and people	All	3.54	3.04	0.36	0.16 (1.99)	0.07* (3.28)	0.49 (0.48)
	F	3.44 (1.44)	2.75 (1.13)	0.49			
	M	3.64 (1.51)	3.33 (1.32)	0.22			

*Means significantly different, $p < .10$, **Means significantly different, $p < .05$, ***Means significantly different, $p < .01$, [#]For all F values the numerator df = 1 and denominator df = 123

Table 3

Mean agricultural and natural resource scores between treatment school and comparison school; group effects size; and main effects of gender, school, and interactions between gender and school.

					p (F Value)[#]		
Variable	Gender	Treatment school *M (SD)*	Comparison school *M (SD)*	Effect size	Gender	School	Gender x School
ANR total	All	12.60	11.86	0.18	0.30 (1.10)	0.36 (0.83)	0.08* (3.14)
	F	12.30 (4.05)	13.00 (3.65)	-0.17			
	M	12.89(4.38)	10.71 (4.05)	0.53			
Agriscience	All	6.28	5.58	0.33	0.61 (0.26)	0.10* (2.75)	0.37 (0.37)
	F	6.20 (2.06)	5.88 (2.16)	0.15			
	M	6.36 (2.20)	5.29 (2.15)	0.50			
Ecology	All	1.42	1.13	0.35	0.95 (0.00)	0.08* (3.09)	0.15 (2.05)
	F	1.30 (0.79)	1.25 (0.68)	0.06			
	M	1.53 (0.92)	1.00 (0.95)	0.63			
Emerging issues	All	0.70	1.04	-0.47	0.33 (0.95)	0.02** (5.69)	0.01*** (8.87)
	F	0.57 (0.69)	1.31 (0.70)	-1.05			
	M	0.84 (0.67)	0.76 (0.83)	0.12			
Scientific method	All	4.20	4.11	0.05	0.16 (2.02)	0.81 (0.06)	0.24 (1.39)
	F	4.24 (1.82)	4.56 (1.79)	-0.18			
	M	4.16 (1.69)	3.67 (1.74)	0.28			

*Means significantly different, $p < .10$, **Means significantly different, $p < .05$, ***Means significantly different, $p < .01$, [#]For all F values the numerator df =1 and denominator df = 124

Table 4

Mean youth leadership life skills development (YLLSD) improvement scores between treatment school and comparison school; group effects size; and main effects of gender, school, and interactions between gender and school.

					p (F Value)#		
Variable	Gender	Treatment school *M (SD)*	Comparison school *M (SD)*	Effect size	Gender	School	Gender x School
YLLSD	All	21.03	23.75	-0.17	0.16 (2.03)	0.40 (0.72)	0.12 (2.44)
	F	20.81 (14.20)	28.56 (17.48)	-0.48			
	M	21.26 (18.53)	18.95 (11.76)	0.14			

*Means significantly different, $p < .10$, **Means significantly different, $p < .05$, ***Means significantly different, $p < .01$, #Numerator df =1 and denominator df = 117

Table 5

Relationship between youth leadership life skills development (YLLSD) improvement scores and science achievement scores for students at the treatment and comparison schools (N = 120)

Variable	*r*	*p*
Science total	0.14	0.14
Scientific investigations	0.08	0.37
Physical science	0.10	0.27
Life science	0.15	0.11
Earth science	0.07	0.42
Science and people	0.17	0.06*

*Correlation significantly different, $p < .10$

Table 6

Relationship between youth leadership life skills development (YLLSD) improvement scores and agriculture and natural resource (ANR) scores for students at the treatment and comparison schools (N = 120).

Variable	*r*	*p*
ANR total	0.18	0.05**
Agriscience	0.14	0.13
Ecology	0.16	0.08*
Emerging issues	0.07	0.47
Scientific method	0.15	0.11

*Correlation significantly different, $p < .10$, **Correlation significantly different, $p < .05$

Table 7

Student career interest at the treatment school and comparison school.

Career	Treatment school *% (f)*	Comparison school *% (f)*
Agriculture and natural resources	13.25 (11)	28.57 (10)
STEM	74.70 (62)	62.86 (22)
Non-STEM	12.05 (10)	8.57 (3)

Conclusions Recommendations and Implications

Results from this study indicated students attending the treatment school showed improved achievement in science based on the MMSAEEC integrated model. Students at the treatment school had improved performance on their overall science scores and in the following subdimensions: scientific investigations, physical science, earth science, and science and people. A lack of difference in life science scores might partially be explained by the fact that one-half of students in the MMSAEEC integrated model did not receive the treatment the year they took life science because one of the two life science teachers did not participate in the treatment program. Additional analysis should be conducted to examine differences in life science scores between those who received the full treatment and those who did not at the treatment school.

Results from the ANR test are less clear. Students at the treatment school had improved performance in agriscience and ecology but achievement needs to be improved on the overall agricultural and natural resource test and in the subdimensions emerging issues and scientific method, where scores are even with or lower than the comparison school. The authors recommend that the MMSAEEC model be enhanced in the area of emerging issues in agriculture and natural resources, particularly for female students. They further recommend that the testing component for the scientific method ANR subdimension of the curriculum be better aligned with the New Mexico standards and benchmarks in scientific investigations (New Mexico Public Education Department, 2005) on which MMS students are performing at a higher level than comparison school students.

Other studies have emphasized that this method of combining science curriculum with experiential learning are effective tools for the development of science skills. For example, Haynes, Robinson, Edwards and Key (2012) found science taught in the context of agriculture improved science achievement. Their study also concluded that an increased amount of exposure to the curriculum would allow for a stronger impact on science achievement. We agree that more long-term results are needed to see what impact the MMSAEEC teaching and learning model will have on long-term science development. This study is part of a larger longitudinal study to determine if longer exposure to the MMSAEEC model will impact student achievement.

Due to the insignificant to weak relationships between youth leadership life skills development scores and science achievement and agriculture and natural resource test scores for students at the treatment and comparison schools, the results will be used to improve overall programming efforts. First, the gathered YLLSDS data will be used as baseline data. Second, item analysis will be conducted to identify which items in the YLLSDS are significantly lower for students at the treatment school, rank these, and use this analysis to make model improvements that will improve the learning experience for MMSAEEC students.

Interest in agriculture and natural resource and STEM related careers (combined) were high for both schools. However, no differences in STEM and ANR career interests were observed between the students from the two schools. The MMSAEEC could do more to interest students in ANR careers. For example, using more ANR resource people working in vicinity in learning activities and having an annual career day for the students from all grades that invites ANR professionals to talk about careers could all be ways that ANR careers could be emphasized.

There are several important implications of the study. Because the MMSAEEC program is in early stages of development, these results provide opportunities to improve areas that are lacking in the model. Summarizing from the conclusions and recommendations above, the key areas for model improvement are in agriculture and natural resources, specifically in emerging issues, leadership life skills development, and ANR career interest. Further research is needed to fully understand why female students at the comparison school were higher than those at the treatment school on the emerging issues portion of the test. Because enhancing mathematics achievement is also a goal of the MMSAEEC integrated model, further research could include comparing math achievement at the treatment and comparison schools. The research could also be used by decision makers to justify program continuation or expansion, and it contributes to the knowledge base necessary to successfully diffuse and implement programs like this at other secondary schools.

This study also has important implications for improving ethnic diversity of students entering STEM educational programs, as minority students are underrepresented in STEM (Gasbarra & Johnson, 2008) and in agriculture and natural resources career fields (Lopez et al., 2005). New Mexico youth rank near the bottom in math and science scores nationally (US Department of Education, 2009). Improving New Mexico student achievement is imperative for it to have a competitive and knowledgeable workforce. The MMSAEEC was established, in part, to address this problem.

Although there is room for improvement in the teaching and learning model, the results of this study indicate student achievement was higher through the MMSAEEC model. Paying particular attention to content, context, and engagement of youth through carefully planned experiential learning activities resulted in improvement in five of six areas of mandated science for students attending the treatment school. This is a critical first step, especially because minorities often have limited awareness of the science demands in agriculture and natural resource careers and often do not even enroll in upper division science courses (Wiley, Bowen, Bowen & Heinsohn, 1997).

In looking for educational models that encourage science achievement, the MMSAEEC model appears promising. The MMSAEEC model has broad implications for inquiry-based learning and experiential education, as well as how programs are delivered affecting youth development in the sciences and the need for new teaching and learning models to engage youth in scientific inquiry. Furthermore, improving achievement in science, agriculture and natural resources for a predominantly Hispanic and economically disadvantaged population is critical to improve ethnic diversity of students entering STEM educational programs and in agriculture and natural resources career fields.

References

Allen, J., Ricketts, J. C., & Priest, K. (2007). Contributions of pre-collegiate and collegiate leadership experiences to alumni leadership development. *North American Colleges and Teachers of Agriculture Journal, September*, 51 (3). 56-61.

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Balschweid, M. A. (2002). Teaching biology using agriculture as the context: Perceptions of high school students. *Journal of Agricultural Education, 43*(2), 56-67. doi:10.5032/jae.2002.02068

Banchero, S. (2011, January 26). Students score poorly on science test. *The Wall Street Journal*. Retrieved from http://online.wsj.com/article/SB10001424052748 704698004576103940087329966.html#articleTabs%3Dcomments

Bloom, B. S. (1956). *Taxonomy of educational objectives, Handbook I: The cognitive domain*. New York: David McKay Co.

Bourdeau, V. D. (2004). 4-H experiential education: A model for 4-H science as inquiry. *Journal of Extension, 42*(5). Article 5TOT3. Retrieved from http://www.joe.org/joe/2004october/tt3.php

Castillo, S. (Ed.). (2003). *New Mexico agriculture, food, and natural resources content standards and benchmarks.* Retrieved from http://www.nmffa.org

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research.* Dallas, TX: Houghton Mifflin Company.

Center for Science, Mathematics, and Engineering Education. (1996). *From analysis to action: undergraduate education in science, mathematics, education and technology.* Washington, DC: National Academy Press.

Cervetti, G. N., Pearson, P. D., Bravo, M. A., & Barber, J. (2006). Reading and writing in the service of inquiry-based science. In R. Douglas, M. P. Klentschy, K. Bender, & W. Binder (Eds.). Linking Science and Literacy in the K-8 Classroom (pp. 221-244). Arlington, VA: National Science Teachers Association.

Chiasson, T. C., & Burnett, M. F. (2001). The influence of enrollment in agriscience courses on the science achievement of high school students. *Journal of Agricultural Education, 42*(1), 61-71. doi: 10.5032/jae.2001.01061

Connors, J. J., & Swan, B. G. (2006). A synthesis of leadership development research in agricultural education:1988-2003. *Journal of Agricultural Education, 47*(2), 1-13.

Dale, E. (1969). *Audio-visual methods in teaching (3rd Edition)*. New York: Holt, Reinhart, and Winston.

Davis, J. A. (1971). *Elementary survey analysis*. Englewood Cliffs, NJ: Prentice Hall.

Doerfert, D. L. (Ed.). (2011). *National research agenda: American Association for Agricultural Education's research priority areas for 2011-2015*. Lubbock, TX: Texas Tech University, Department of Agricultural Education and Communications.

Dormody, T. J., & Seevers, B. S. (1994). Predicting youth leadership life skills development among FFA members in Arizona, Colorado, and New Mexico. *Journal of Agricultural Education, 35*(2), 66-71. doi: 10.5032/jae.1994.02065

Dormody, T. J., Seevers, B. S., & Clason, D. L. (1993). *The Youth Leadership Life Skills Development Scale: An evaluation and research tool for youth organizations* (Research Report 672). New Mexico State University, Agricultural Experiment Station.

Durlack, J. A. (2009). How to select, calculate, and interpret effect sizes. *Journal of Pediatric Psychology, 34*(9), 917-928. doi: *10.1093/jpepsy/jsp004*

Gasbarra, P., & Johnson, J. (2008). Out before the game begins: Hispanic leaders talk about what's needed to bring more Hispanic youngsters into science, technology, and math professions. Retrieved from http://www.publicagenda.org/files/pdf/outbefore.PDF

Goecker, A. D., Smith, P. G., Smith, E., & Goetz, R. (2010). Employment opportunities for college graduates in food renewable energy and the environment. United States Department of Agriculture. Retrieved from http://www3.ag.purdue.edu/USDA/employment/Documents/USDAEmployOp2010.pdf

Haynes, C. J., Robinson, J. S., Edwards, M. C., & Key, J. P. (2012). Assessing the effect of using a science-enhanced curriculum to improve agricultural students science scores: A casual comparative study. *Journal of Agricultural Education, 53* (2), 15-27. doi: 10.5032/jae.2012.02015

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* New Jersey: Prentice-Hall.

Legislature of the State of New Mexico. (2003). *House Bill 212 as Amended. [*Available from the Office of the Chief Clerk, New Mexico House of Representatives, Room 100, State Capitol, Santa Fe, New Mexico, 87501].

Lopez, R., Lopez, A., Wilkins, R., Torres, C., Valdez, R., Teer, J., & Bowser, J. (2005). Changing Hispanic demographics: Challenges in natural resource management. *Wildlife Society Bulletin, 33*(2), 553–564.

McKinley, B. G., Birkenholz, R. J., & Stewart, B. R. (2010). Characteristics and experiences related to the leadership skills of agriculture students in college. *Journal of Agricultural Education, 34* (3), 76-83**.** doi: 10.5032/jae.1993.03076

National Academy of Sciences. (2009). *Transforming agricultural education for a changing world*. Washington DC: National Academies Press.

New Mexico Public Education Department. (2005). *New Mexico standards, benchmarks, and performance standards reference guide*. [Available from the New Mexico Public Education Department, Jerry E. Apodaca Education Building, 300 Don Gaspar Avenue, Santa Fe, NM, 87501-2786, and at www.ped.state.nm.us]

New Mexico State University. (2008). *Off-campus science centers.* Retrieved from http://cahe.nmsu.edu/aes/offcampus.html

Park, T. D., & Dyer, J. E. (2005). Contributions of agricultural education, FFA, and 4-H to student leadership in agricultural colleges. *Journal of Agricultural Education, 46(*2), 83-95. doi: 10.5032/jae.2005.02083

Phipps, L. J., & Osborne, E. W. (1988). *Handbook on agricultural education in public schools*. Danville, IL: The Interstate Printers & Publishers, Inc.

Ramsey, F. L., & Schafer, D. W. (2002). *The Statistical Sleuth: A Course in Methods of Data Analysis, 2nd ed.* Belmont, CA: Duxbury Press.

Roegge, C. A., & Russell, E. B. (1990). Teaching applied biology in secondary agriculture: Effects on student achievement and attitudes. *Journal of Agricultural Education, 31*(1), 27-31. doi: 10.5032/jae.1990.01027

Rohs, F. R. (1999). Response shift bias: A problem in evaluating leadership development with self-report pretest-posttest measures. *Journal of Agricultural Education, 40*(4), 28-37. doi: 10.5032/jae.1999.04028

Rosch, D. M.. & Coers, N. (2013). How are we educating agricultural students? A national profile of leadership capacities and involvement in college compared to non-agricultural peers. *Journal of Agricultural Education 54*(1), 83-96. doi: 10.5032/jae.2013.01083

SAS Institute Inc. 2010.SAS® 9.2 Language Reference: Concepts, Second Edition . Cary, NC: SAS Institute Inc.

Seevers, B. S., & Dormody, T. J. (1994). Predicting youth leadership life skills among senior 4-H members: A tri-state study. *Journal of Agricultural Education, 35*(3), 64-69. doi: 10.5032/jae.1994.03064

Seevers, B. S., Dormody, T. J., & Clason, D. L. (1995). Developing a scale to measure youth leadership life skills development. *Journal of Agricultural Education, 36*(2), 28-35.

Simonsen, J. C., & Birkenholz, R .J. (2010). Leadership courses required in agricultural teacher education programs. *Journal of Agricultural Education, 51*(3), 114-124. doi: 10.5032/jae.2010.03114

Skelton, P., & Dappen, P. (2008). *Memorial Middle School Agricultural Extension and Education Center.* Retrieved from the Memorial Middle School Agricultural Science Center Web site: http://mmsaeec.nmsu.edu

Skelton, P., & Dormody, T. (2009). Adding context to content: The Memorial Middle School Agricultural Science Center Model. *The Agricultural Education Magazine*, *81*(5), 26-28.

Skelton, P., & Seevers, B. (2010). A new extension model: The Memorial Middle School Agricultural Extension and Education Center. *Journal of Extension,* 48(6), Article 6IAW5.

Skelton, P., Seevers, B., Dormody, T., & Hodnett, F. (2012). A conceptual process model for improving youth science comprehension. *Journal of Extension*, *50*(3), Article 3IAW1.

Swinehart, B. (1992). *Youth involvement: Developing leaders and strengthening communities*. Boulder, CO: Partners for Youth Leadership.

Thompson, G. W., & Warnick, B. K. (2007). Integrating science into the agricultural education curriculum: Do science and agriculture teachers agree? *Journal of Agricultural Education, 48*(3), 1-12. doi: 10.5032/jae.2007.03001

United State Department of Education. (2001). *No Child Left Behind Act of 2001*. Retrieved from http://www.NoChildLeftBehind.gov

United State Department of Education. (2009). *The facts about science achievement*. Retrieved from http://www.ed.gov/nclb/methods/science/science.html.

Wiley, Z.Z. Bowen, B.E. Bowen, C.F. & Heinsohn, A.L. (1997). Attitude formulation of ethnic minority students toward food and agricultural sciences. *Journal of Agricultural Education, 38*(2), 21-29. doi: 10.5032/jae.1997.02021