Examining Differences in Middle School Student Achievement on a State Mandated Examination: Does a Full Year of Agriscience Really Make a Difference?

Abstract

Early agricultural education programs in the United States existed to promote new methods and techniques to further agricultural production. Today, extending integration, general knowledge, appreciation, and literacy about agriculture is the goal, especially at the middle school level. Not only is agricultural education designed to encompass academics, but science and technology, literacy, and career preparedness are parts of the total agricultural education program. Since the passage of No Child Left Behind Act (NCLB), more pressure has been put on teachers to generate increased student academic performance and improvement of test scores. The purpose of this research study was to determine if there were statistically significant differences in academic achievement on a state mandated assessment of students who completed a yearlong middle school agricultural education course and students who completed only an eight week middle school agricultural education course in the same school, with the same instructor; the significance in time spent in the course was the main issue in question. The findings showed a statistically significant relationship between the completion of the year-long agricultural education course and math, science, and social studies scores on the state mandated assessment. For example, both 7th and 8th grade students who completed a year-long brain-based agricultural education course had higher mean scores than students who completed only an eight-week brain-based agricultural education course on the math, science, and social studies portions of the assessment.

Key words: agricultural education; standardized tests; middle school students; agriscience

Introduction

Congress reviewed and revised the Elementary and Secondary Act of 1965 to create the No Child Left Behind Act (NCLB) which was signed into law by President Bush in January of 2001. The law holds states accountable for students' academic achievement and measured adequate yearly progress (AYP) for each public school (Linn, Baker, & Betebenner, 2002). In response, each state developed an assessment standard as well as proficiency standards for each core area (Reeves, 2008). In Georgia, the Criterion-Referenced Competency Test (CRCT) was developed to measure AYP statewide. "The CRCT program is designed to measure student acquisition of the knowledge, concepts, and skills set forth in the state curriculum. The testing program serves a dual purpose: 1) diagnosis of individual student and program strengths and weaknesses as related to instruction of the Georgia Performance Standards, and 2) a measure of the quality of education in the state" (Cox, 2007, p. 3). The former AYP system was replaced by College and Career Ready Performance Index (CCRPI) in the 2013-2014 school year, under which all Criterion-Referenced Competency Test (CRCT) content area scores count towards calculating the school's index; meaning all subject areas are of equal importance ("College and Career Ready Performance Index", n.d.).

Early agricultural education programs in the United States existed to promote new methods and techniques to further agricultural production (Phipps et al., 2008). Today, extending integration, general knowledge, appreciation, and literacy about agriculture is the goal, especially at the middle school level. Not only is agricultural education designed to encompass academics, but science and technology, literacy, and career preparedness are parts of the total agriculture program . Gibbs (2005) wrote that traditional career exposure has occurred at the high school level, but that today, administrators and educators realize that "developing students' interest must be addressed earlier at the middle school level" (p. 1). In addition, the incorporation of agricultural education into the total middle school curriculum has called for integration of academic and applied concepts. Echoing these sentiments, the American Association for the Advancement of Sciences (1993) recommend connecting what students learn through interdisciplinary links in school, real-world connections, and associations to the real-world of work.

Since the passage of NCLB, more pressure is put on teachers to generate increased student academic performance and improvement of test scores. Using the three facets of an agricultural education program (FFA, Instruction, and SAE) to reinforce academic concepts is one technique suggested to improve test scores (Martin, Fritzsche, & Ball, 2006). Therefore, completion of a yearlong agricultural education course perhaps has an impact on academic achievement of students when compared to those who completed a much shorter, eight week agricultural education course, even when both courses were taught by the same instructor, using the same methods.

Standardized Georgia Middle School Agricultural Education Curriculum was developed to address the vast industry of agriculture for students grades six through eight. The complete Georgia Middle School Agricultural Education curriculum fits into a three part model (Figure 1) which includes classroom and laboratory experiences, Supervised Agricultural Experience projects (SAE), and National FFA Organization activities which are referred to as career development events (CDE). Classroom and laboratory experiences within agricultural education facilitate the standardized state-wide curriculum; hands-on activities, problem-solving, and inquiry based techniques are utilized by agriculture educators within classroom and laboratory instruction (Parr & Edwards, 2004). Another component of agricultural education is the Supervised Agriculture Experience (SAE). This portion of the curriculum involves extension of classroom learning and situational application of agricultural principles (Newcomb, McCracken, Warmbrod, & Whittington, 2004; Phipps, Osborne, Dyer, & Ball, 2008; Talbert, Vaughn, Croom, & Lee, 2007). There are four types of SAE projects; exploratory, research, placement, and entrepreneurship, all of which are applicable to all academic subject areas. For example, the research SAE is directly related to science curriculum involving the scientific method (Roberts & Harlin, 2007). This type of SAE provides students with opportunities to apply scientific methods and concepts in meaningful, hands-on ways. This also allows students to extend their existing knowledge, reinforce concepts, and gain real-world experiences (Croom, 2008).

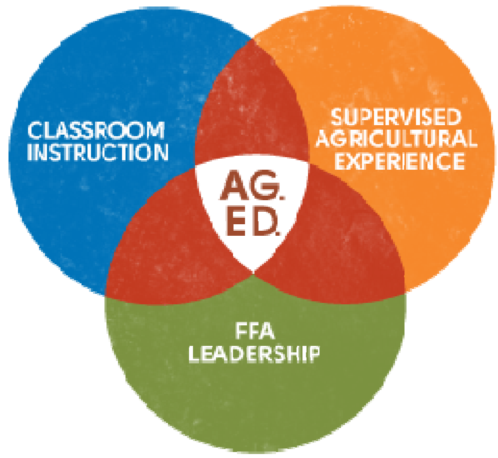

Figure 1. Three-Ring Model of Agricultural Education

The idea of involving students in after school activities that directly relate to their academic learning is the foundation for involvement in the third part of a complete agriculture program, the National FFA Organization. The FFA organization is dedicated to making "a positive difference in the lives of students by developing their potential for premier leadership, personal growth, and career success through agricultural education" (National FFA Organization, 2011, p. 1). The FFA is a essential component in agricultural education and sponsors student competitions called Career Development Events (CDE). The academic foundations of CDEs that students participate and compete in reflect academic concepts in a meaningful, application-based situation, thus creating opportunities for experiential learning (Gentry, 1990).

Theoretical Framework

Instruction that is guided by brain-based learning theory engages techniques and methods that are guided by the brain's development and maximizes the potential for learning. Unlike most learning theories, brain-based theory states that learning is "innately linked to the biological and chemical forces that control the brain" (Hileman, 2006, p. 18). Additionally, Caine and Caine (1994) posited that the brain is designed to make sense of the world through experience with the big picture (agriculture) and by paying attention to the details of individual parts (science concepts). The brain-based learning theory is a comprehensive approach to instruction utilizing what is known about how the brain functions and learns and it utilizes an eclectic combination of learning theories and models to help teachers connect learning styles and educational experiences. Brain-based research stresses the importance of modeling, verbally, socially, professionally, and emotionally. Not only is the researcher/teacher a facilitator of student learning, but also a walking example to the students and should strive to be a positive role model at all times (Knoblock, 2006).

Lastly, brain-based learning theory posits that using a diverse array of learning experiences and pedagogical time intervals that match how students' brains are developing at a given time increases the probability of learning successfully (Bellah, et al., 2008). The elements of brain-based learning theory fit the classroom environment in this research study because the experiences within the agriculture classroom in question compliment the needs of a developing brain and follow many brain-based instructional strategies. For example, according to this theory, activities should change within 12-15 minutes; this is the time-frame for activities within the researcher’s classroom. Also, the teacher in this study utilized repetition of terms, concepts, themes, and learning daily, often restating new knowledge several different ways at various times during the duration of a class. For example, when teaching embryology, various stations are utilized which accommodate various learning styles and methods of instructional presentation. Thus, students input information about how the embryonic egg develops in multiple ways (visually, through reading and hearing the information read aloud, as well as kinesthetically The novelty of topics and experiences are promoted to encourage contextualization and interest and the researcher’s teaching strategies utilize brain-based instructional methods to facilitate the diverse state agricultural education curriculum.

Previous research spanning nearly two decades (Chiasson & Burnett, 2001; Enderlin & Osborne, 1992; Enderlin, Petrea, & Osborne, 1993; Ricketts, Duncan, & Peake, 2006; Shultz, Duncan, Ricketts & Herren, 2007; Rich, Duncan, Navarro & Ricketts, 2009) has concluded that students completing courses in agricultural education at both the middle and high school levels has had a positive impact on student performance of state mandated assessments in math, science and social studies, but, no study currently exists to compare results of standardizes tests of middle school students who spent extended time (a full academic year) in an agricultural education course with those who only spent the traditional eight weeks in an agricultural education course. Since both courses in this study featured the same instructor who used brain-based instructional methods, the time spent in the course can be examined to determine relationships between course length and academic achievement on standardized tests; hence the need for this study.

Purpose

The purpose of this research study was to determine a relationship exists between the length of agricultural education course completed and academic achievement on standardized tests. The following research question guided this study: is there is a statistically significant difference in math, science and social studies CRCT scores of students who completed a year-long agricultural education course that was guided by brain-based instruction and students who completed only an eight-week agricultural education course that was also guided by brain-based instruction?

Method

This descriptive study utilized a static-group comparison design in which two groups were identified (yearlong and 8-week students) and the CRCT was used as a posttest in order to compare mean math, science, and social studies scores from groups of seventh and eighth grade students during two consecutive school years. Static-group comparison design was used because it allowed the researcher to gather data from a large number of subjects at one time, provided the opportunity for a snap-shot of variable relationships, and served the researcher’s goals by providing an exploratory tool to gathering data at one time. The CRCT scores of special education students and those with Individualized Education Plans (IEP) who took the CRCT with modifications such as extended time or having it read aloud were included in this study. By retaining the scores of these two student groups a true snapshot of actual student knowledge was attained. It also made the testing groups more authentic as it included all students, not excluding special needs students which are usually a subgroup and are pulled out of the general education testing groups. Also, previous investigations addressed the academic impact of agricultural education on students with special needs and the purpose of this study was not to replicate previous studies (Rich, Duncan, Navarro, & Ricketts, 2009; Clark, 2012).

During one school year, two year-long agriculture classes are taught to seventh graders and two are taught to 8th graders. This combines for a total of four classes of students who complete a yearlong agriculture class each year. In addition to the four yearlong classes, there are simultaneously being taught four courses which last only eight weeks. There are four sets of eight week long courses taught each year. Therefore, a total of 16 eight-week agriculture classes are taught each year (two each eight weeks to 7th graders, and two to 8th graders) while only four year-long classes are taught.

The target population for this study was the 260 total students who completed the year-long agricultural education course (N = 260, 130 8th grade and 130 7th grade students). The eight-week agriculture class completers, of which 130 were 7th graders, 130 were 8th graders, were chosen to create a sample ($n = 260$) by a co-researcher who randomly selected students from the population group. It must be noted that the agricultural education courses were taught in the same school system by the same teacher whose instruction in both courses was guided by brain-based research. Students in this school are randomly put in the agricultural education courses; they had no choice in their placement either in the yearlong or eight week course; therefore, intention to be in the course played no role in their being in the course. Also, no attention was given to the genders or status of special education students in any course. A mix of girls and boys, regular and special education students existed in all classes.

Using existing CRCT data, group comparisons were made. The data collection (CRCT examination) were administered and collected uniformly. Therefore, consistency in data collection and analysis was very probable. The data were de-identified by school personnel other than the researcher and provided to the researcher grouped according to completion of the yearlong or eight-week agriculture class. The researcher was provided only with the scores, sorted into their respective groups, so the researcher had no access to identifiable student information to ensure the anonymity of its participants.

Findings

All sections of the CRCT feature approximately 70 multiple choice questions. The State Department of Education sets the score standards for meeting or exceeding the standard. For example, scores below the state's designated level of proficiency of 800 do not meet the standard and therefore, fail that portion of the CRCT. Scores above 850 are considered exceeding the standard and those between 800 and 849 indicate that the student met the standard for that portion of the test. These levels are considered the same for all CRCT subjects.
As seen in Table 1, seventh grade yearlong mean scores for every subject above 850 ("exceeded" category) while eight-week mean scores ranged from 823 to 827 ("met the standard" category). Additionally, there was nearly a five percent increase in CRCT mean scores for science of yearlong completers when compared to eight-week students.

Table 1
Seventh Grade Mean Score Differences and Percent Increase

	Math	Science	Social Studies

Yearlong (n=130)	850.13	866.23	861.81
SD	30.36	34.02	43.45
Eight-Week (n=130)	823.11	823.03	827.16
SD	28.69	40.20	32.37
Cohen's d	.914	1.16	.904
Difference	27.02	43.20	34.65
Percent Increase	3.28	4.99	4.02
F Value	55.03	89.53	53.58
P Value	<.0001	<.0001	<.0001
Degrees of Freedom	1, 129	1, 129	1, 129

Note: Yearlong students took the course for 32 weeks versus only 8 weeks.

Regarding the 8th grade scores, although none of the yearlong mean scores were "exceeding," they were all above 830 while the eight-week group mean scores ranged near 800, the baseline for passing the Criterion Referenced Competency Test (Table 2). Additionally, on the math portion, the mean score for yearlong students was 17.93 points higher (M = 830.88) than the mean score of the eight-week students (M = 812.95). Lastly, it must be noted that the largest increase in student performance was the social studies portion of the CRCT.

Table 2
Eighth Grade Mean Score Differences and Percent Increase

	Math	Science	Social Studies
Yearlong (n=130)	830.88	832.68	842.45
SD	26.91	24.27	35.57
Eight-Week (n=130)	812.95	815.66	813.11
SD	25.99	21.87	27.03
Cohen's d	.678	.737	.929
Difference	17.93	17.02	29.34

Percent Increase	2.16	2.04	3.48
F Value	29.84	35.26	56.07
P Value	<.0001	<.0001	<.0001
DF	1, 129	1, 129	1, 129

Note: Yearlong students took the course for 32 weeks versus only 8 weeks.

Conclusions

Exposure to yearlong brain-based agricultural education had a positive effect on student standardized test scores for the Georgia CRCT. The findings of this study showed a statistically significant relationship between the completion of the yearlong agricultural education course and math, science, and social studies scores on the CRCT. As previously noted, earlier studies found similar results for both middle and high school students who were either completed a year-long course or multiple semesters (Shultz, Duncan, Ricketts & Herren, 2007; Rich, Duncan, Navarro & Ricketts, 2009). Thus, it can be stated that completion of a year-long agricultural education course that utilizes brain-based learning theory has a positive influence on academic achievement on Georgia's Criterion Referenced Competency Test.

In this study, both 7^{th} and 8^{th} grade students who completed a yearlong brain-based agricultural education course had higher mean scores than students who completed only an eight-week brain-based agricultural education course on the math, science, and social studies portions of the CRCT. Overall, the 7^{th} grade yearlong students' mean scores were 3.28% higher on the math portion, 4.99% higher on the science portion, and 4.02% higher on the social studies portion of the CRCT in comparison to eight-week completers. In addition, comparisons between the two 7th grade groups' scores indicate an effect size of .914 on the math portion, 1.16 on the science portion, and .904 on the social studies portion. Having all effect sizes exceed 0.8 indicate that completion of the year-long agriscience course had a large effect for students.

Eighth grade yearlong students scored 2.16% higher on the math, 2.04% higher on the science, and 3.48% higher on the social studies portion of the CRCT in comparison to eight-week completers. Effect size for these comparisons all indicate at least a medium amount of influence on math (.678) and science (.737) scores by completing the yearlong agricultural education course, and a large influence (effect size of .929) on student's social studies scores. Yearlong mean scores on all three portions of the CRCT "exceeded" the standard in the 7^{th} grade. This is likely due to the nature of the 7^{th} grade standards being more easily incorporated into the agricultural course than 8^{th} grade standards. Math standards in 7^{th} grade utilize charts, graphs, fractions, and statistical concepts which can be seamlessly integrated into any agricultural unit. Seventh grade social studies standards feature economic concepts, entrepreneurship, and elements of trade throughout the world. These concepts are taught within agricultural education in units featuring world economies, small business, entrepreneurship concepts, and globalization.

A contrast occurs in the 8^{th} grade where standards are more abstract in math and science but more relatable to agriculture in social studies. Eighth grade math standards feature concepts not as easily incorporated into agricultural education such as linear equations, geometry, volume of shapes, and the Pythagorean Theorem. Science standards focus on cellular science, chemical changes, and electricity. Social studies standards focus on Georgia studies, topics that can very easily be incorporated in agricultural education courses in Georgia which perhaps accounts for 8th grade yearlong social studies scores nearly reaching the *exceeding* mark of 850 with an 842.45, a full 29.34 points above the eight-week group's mean score of 813.11.

Under Georgia's new College and Career Readiness Performance Index (CCRPI), all standardized test scores count as part of the school's total score. Because of this, now, more than ever, non-academic teachers are pressured to contribute positively to their students' total academic success. Findings from this study suggest that accounting for student's brain development within instructional strategies used increases the likelihood of students internalizing the information being presented. Thus, when academic integration occurs in the vocational setting which allows for hands-on and tangible experiences, or brain-based instruction, academic success is more probable. Much like the pioneers of vocational education, John Dewey and Charles Prosser posited, students learn better when what is being taught is meaningful and tangible. The findings of this study indicate that academic integration into agricultural education has a tremendous potential effect on student academic success.

Recommendations

As more is learned about brain development, strategies that incorporate and test new information should be used, and perhaps even combined with existing knowledge about how the brain learns at given stages of growth. This study recognized that extended exposure to agricultural education which utilizes brain-based instruction has a positive impact on academic achievement of students. Therefore to increase the likelihood of making a positive impact on student academic achievement through agricultural education, further education on brain-based methods should be included in teacher education preparation programs and professional development for existing teachers. Training on how to implement brain-based methods while integrating academic concepts and collaborating with academic teachers also should be emphasized by student-teacher supervisors and professional development planners. In addition, given the results of this study, the yearlong agricultural education course appears to have a positive influence on student academic achievement, and therefore guidance counselors and student schedulers should encourage students to enroll in a yearlong course.

Academic teachers should also seek opportunities and resources available within the agricultural education setting to supplement and reinforce academic content. Examples of this include using a greenhouse to teach global warming or reproduction; a barn could house chickens and afford opportunities to incubate eggs, reinforcing life science concepts and allowing authentic examples. Language arts or literature teachers should link their material to the agricultural education courses being taught at their school, affording opportunities for collaborative units where all academic subject areas utilize the same material to teach related standards. The science teacher could then teach about soils and elements within the earth and atmosphere that allow plants to live, while the social studies teacher highlights the area's topography and uses a map to outline gardens or graph the rows of green beans the students planted, teach map skills, as well as how to use a scale and cardinal directions.

The topic of yearlong agriculture classes is a prime area for additional research. Recommended areas of research include qualitative studies of teachers, administrators, and students focused on the implementation, benefits, and barriers to providing yearlong agricultural education courses. Gaining teacher, administrator, and student perceptions on this topic through qualitative research will provide a means to guide further school schedule development as well as pathway planning. It would also be constructive to determine how many students, who begin their pathway enrolled in the yearlong agriculture class, actually finish an agriculture pathway in high school. Gaining this type of information, along with perceptions of administrators, teachers, and students about the malleable factors that they believe contributed to completion will provide more information for planning and improving the pathway completion rates. Such longitudinal studies would also help researchers gain insight on the process of pathway completion. In addition, further research should seek to determine if the completion of a yearlong pathway class at the middle school level increases the odds of completing the entire pathway once in high school. This type of information could lend itself easily to legitimizing additional yearlong classes at the middle school level.

Implications

This study identified the positive relationship between yearlong brain-based agricultural education instruction and standardized test scores, thus, more research is recommended to further explore their connection. Additional research concerning extended exposure to brain-based methods, using both qualitative and quantitative methods to determine the most effectively used brain-based methods in agricultural education instruction, teacher preparedness to utilize such methods, and teacher perceptions of their use is needed. Also, although a cadre of research currently exists concerning the barriers to, benefits of, and ways to integrate academic concepts into agricultural education, there is limited research that focuses on how brain-based instruction is used to integrate academics into non-academic settings. The findings of this study indicate that indeed, there is a difference in the academic achievement on standardized tests of students who completed a yearlong agriculture education course that was taught using brain-based methods and those that completed only an eight week course. The effect size calculations indicate that the groups who completed the yearlong course were largely impacted by that fact compared to the groups who completed only the eight-week course. Therefore, attention should not only be given to brain-based methods of instruction, but also to promotion of year-long agricultural education courses within the middle school setting.

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