Journal of Agricultural Education, 59(1), 70-85
https://doi.org/10.5032/jae.2018.01070

A National Analysis of School-Based Agricultural Education Involvement, Graduation, STEM Achievement, and Income

Aaron J. McKim[1], Jonathan J. Velez[2] & Tyson J. Sorensen[3]

Abstract

The progression of research on school-based agricultural education (SBAE) has been limited, in part, due to a lack of nationwide, student data detailing the effectiveness of SBAE. Using an ecological systems perspective, the relationships between SBAE enrollment; graduation rates; postsecondary science, technology, engineering, and mathematics (STEM) achievement; and income were explored using data from a nation-wide, longitudinal study conducted from 2002 to 2012. Results indicate SBAE students were more likely to be male, white, and have a lower socio-economic status than students not enrolled in SBAE. With regard to graduation rates, SBAE enrollment was a statistically significant, positive predictor of high school graduation. In fact, students enrolled in SBAE were 1.16 times more likely to graduate high school than students not enrolled in SBAE. In the analysis of STEM achievement, SBAE enrollment was a statistically significant, negative predictor of postsecondary science, math, and overall STEM GPA. With regard to income, each additional Carnegie unit of SBAE was related to $1,850.67 more annual income for high school graduates and $457.40 more annual income for postsecondary graduates. Findings are discussed in relation to the ecological systems theory, with an emphasis on recommendations for research and practice.

Keywords: school-based agricultural education; graduation; science achievement; math achievement; STEM achievement; income

Introduction and Theoretical Framework

As a smaller profession, with limited resources, researchers in school-based agricultural education (SBAE) have a difficult time developing nationwide, longitudinal studies which examine the effectiveness of SBAE. The lack of large-scale research leads to conversations about SBAE being riddled with questions such as "I wish we knew nationally if SBAE impacted STEM achievement" or "Is SBAE better preparing students for career success?" To continue forward, SBAE needs to answer the questions which directly impact the discipline. The goal of the current paper is to begin to answer a few of the critical, unanswered questions. In answering key questions, we welcome the potential cognitive disequilibrium created and embrace the opportunity to gain insight into opportunities to enhance and support SBAE.

[1] Aaron J. McKim is an Assistant Professor in the Department of Community Sustainability at Michigan State University, 480 Wilson Road Room 131, East Lansing, MI 48824, amckim@msu.edu.

[2] Jonathan J. Velez is an Associate Professor in the Department of Agricultural Education and Agricultural Sciences at Oregon State University, 108 Strand Agriculture Hall, Corvallis, OR 97331, jonathan.velez@oregonstate.edu.

[3] Tyson J. Sorensen is an Assistant Professor of Agricultural Education in the School of Applied Sciences, Technology and Education at Utah State University, 2300 Old Main Hill, Logan, UT 84322, tyson.sorensen@usu.edu.

The current study seeks to break down prior limits of discourse regarding SBAE by identifying the relationship between SBAE enrollment, graduation rates, STEM achievement, and income using a national sample of secondary school students. Identifying the relationship between SBAE and critical outcomes will provide an opportunity for the discipline to reflect, plan, collaborate, and act in a more purposeful and informed manner. Additionally, the present study will account for three common limitations of current research which decrease our ability to holistically address the impacts of SBAE. Namely, limited generalizability due to non-longitudinal and state-wide studies, failure to account for mediating factors (e.g., sex, race, and socio-economic status), and failure to address STEM concepts other than science and math.

To provide a foundation on which to assess critical questions, we operationalized an ecological systems perspective (Bronfenbrenner, 1993; Lerner, 1995). The Ecological Systems theory posits human development and behavior are influenced by factors within different levels of environmental systems (i.e., individual, microsystem, mesosystem, exosystem, and macrosystem). Theorists with an ecological systems perspective contend a hierarchy of factors influence educational achievement (Bronfenbrenner, 1993). For example, because students (i.e., individual level) are rooted within a school system (i.e., microsystem and mesosystem), the teacher-student interaction, student-peer interaction, and student-academic program interaction can influence achievement. The emphasis of the current study is on the micro- and mesosystems; specifically, the influence of SBAE enrollment on graduation, STEM achievement, and income.

Literature Review

Three important outcomes related to secondary student enrollment in SBAE are considered in the current study: (a) graduation rates, (b) STEM achievement, and (c) income. Within the following review of literature, each of the identified outcomes are explicated by exploring literature throughout education.

High School Graduation

Dropping out of school has been a concern in American society for decades. In 2010, the Alliance for Excellence in Education (2010) reported approximately 1.3 million American children do not graduate each year, with about 7,000 students dropping out every day. Research indicates students most likely to drop out of school are of low academic ability, ethnic minority groups, or families in which parents did not graduate high school (Goldschmidt & Wang, 1999; Rumberger, 1995; Rumberger & Larson, 1998; Swanson & Schneider, 1999). Dropping out has negative effects on both the individual and society. Students who drop out are more likely to experience health problems, engage in criminal activity, earn less money, become dependent on government assistance programs, and not participate in the social or political process (Bridgeland, DiIulio, & Morison, 2006; Federal Student Aid Information Center, 2011; Hayes, Nelson, Tabin, Pearson, & Worthy, 2002; Martin, Tobin, & Sugai, 2003; Muennig, 2007).

The relationship between SBAE enrollment and graduation rates has received little attention in the literature. However, numerous studies have demonstrated a positive relationship between Career and Technical Education (CTE) and graduation (Plank, 2001; Plank, DeLuca, & Estacion, 2005). Additionally, evidence suggests CTE has a positive impact on the graduation rates of at-risk and special needs students, who enroll in CTE courses at a higher rate (Gray, 2004; Okou, 2004). In SBAE, FFA (i.e., a co-curricular student leadership organization) is an integral component of the curriculum (Croom, 2008). Research suggests additional experiences, similar to FFA, reduce drop out (Mahoney & Cairns, 1997); more specifically, extracurricular activities yield students 2.3 times more likely to remain in school (Davalos, Chavez, & Guardiola, 1999).

Furthermore, Bridgeland et al. (2006) suggest work-related experiences, which are foundations of SBAE, could have improved the graduation chances for 81% of dropouts. SBAE appears to offer graduation-enhancing experiences; unfortunately, no research has explored the relationship between graduation rates and SBAE enrollment on a national scale.

STEM Achievement

A large body of research indicates CTE courses offer opportunities to learn core academic (e.g., science, math) content (Brigman & Campbell, 2003; Dahir & Stone, 2003; Gysbers & Lapan, 2001; Silverberg, Warner, Fong, & Goodwin, 2004). However, research on the efficacy of academic learning within CTE courses has produced mixed results. Some studies suggest CTE students lag behind in mathematics achievement compared to students in other academic tracks (Crain et al., 1999; Plank, 2001) while other studies suggest students perform better in mathematics when it is integrated into CTE coursework (Nolin & Parr, 2013; Stone, Alfred, Pearson, Lewis, & Jensen, 2006). Similar to math, results vary in terms of SBAE enrollment and science achievement (McKim, Velez, Lambert, & Balschweid, 2017). Some studies suggest enhanced science learning among SBAE students (Chiasson & Burnett, 2001; Ricketts, Duncan, & Peake, 2006; Ross, 2001; Theriot & Kotrlik, 2009) while others identify no statistical difference (Connors & Elliot, 1995; Nolin & Parr, 2013) or significantly lower science achievement (Despain, North, Warnick, & Baggaley, 2016; Israel, Myers, Lamm, & Galindo-Gonzalez, 2012). Mixed results intensify the need for national research on the STEM achievement of SBAE enrollees.

Income

Income, the third outcome variable, has been sparsely explored in SBAE. However, in CTE, a 12-year longitudinal study indicated individuals who devoted about one-sixth of their high school enrollment to CTE earned at least 12% more one year after graduation and about 8% more seven years after graduation (Bishop & Mane, 2004). Another study compared CTE and non-CTE students who go directly into the workplace and found CTE students earned higher wages and were more likely to be employed in higher wage segments of the economy (Huang & Gray, 1992).

Existing research illuminates the potential for CTE, and in some cases SBAE, to positively influence graduation rates, STEM achievement, and income. However, for SBAE to advance, three important limitations must be addressed: (a) research specific to SBAE, (b) national research, and (c) attention to mediating factors such as sex, race, and socio-economic status (SES). In the current study, we sought to address the identified limitations by exploring the relationship between SBAE involvement, graduation rates, STEM achievement, and income among a national sample of secondary school students when accounting for sex, race, and SES.

Purpose and Objectives

The purpose of the current study was to explore the relationship between SBAE enrollment, graduation rates, STEM achievement, and income among a nationally representative sample of secondary school students. The identified purpose was accomplished by addressing the following research objectives.

1. Describe the sex, race, and socio-economic status (SES) of public school students.

2. Determine the relationship between SBAE enrollment and high school graduation, accounting for sex, race, and SES.

3. Determine the relationship between SBAE enrollment and measureable achievement in STEM, accounting for sex, race, and SES.

4. Determine the relationship between SBAE enrollment and income, accounting for sex, race, and SES.

Methods

Research objectives were accomplished by analyzing data from the National Center for Educational Statistics (National Center for Educational Statistics, 2002), Educational Longitudinal Study (ELS:2002-2012), initially collected from 2002 to 2012. We retained a restricted use data file to allow for the tracking of students through 2012. The final data release, including postsecondary data, occurred in April 2015.

Population and Data Collection

The population for this study included all American high school sophomores in the spring of 2002. A stratified sample was utilized to reduce sampling error and to create subgroups of schools from which schools were independently selected. Initially, schools were stratified by superstrata (i.e., school type or sector and geographic region) and substrata (i.e., urban, suburban, rural) (U.S. Department of Education, 2004). A total of 800 high schools were selected, with 752 schools agreeing to participate (94% participation rate). Once schools agreed to participate, a rigorous recruitment process began with students, teachers, parents, librarians, and school administrators. In total, 15,362 high school sophomores from 50 states and the District of Columbia participated. Additional detailed methodological information can be found in the U.S. Department of Education, National Center for Educational Statistics, Education Longitudinal Study of 2002: Base Year Data File User's Manual (2004). With the exception of the first research objective, analysis was limited to public schools where SBAE was offered. Private schools, charter schools, or religiously affiliated schools were not included in the research frame.

Statistical Analysis

For the first research objective, descriptive statistics were used to describe the population. Objectives two to four were accomplished via logistic and linear regressions, after accounting for the four primary assumptions of regression analyses (Hair, Anderson, Tatham, & Black, 2006). Research objective one, pertaining to the actual demographics of the sample, was analyzed using unweighted data while research objectives two to four were analyzed with weighted data. Weighting data is typical to compensate for unequal probabilities of sample selection and to adjust for actual participation in the survey (U.S. Department of Education, 2004). The use of weighted data afforded enhanced statistical clarity, enabling generalizations to all high school sophomores enrolled in the United States in 2002.

During statistical analysis, several variables were considered which, while commonly used, bear explanation. Carnegie units were used as a categorical descriptor of SBAE units. Carnegie units are defined as, "A standard of measurement used for secondary education that represents the completion of a course that meets one period per day for one year" (U.S. Department of Education, 2004, p. E-17). Socio-economic status (SES) was a composite variable which included five equally weighted standardized categories: (a) father's/guardian's education, (b) mother's/guardian's education, (c) family income, (d) father's/guardian's occupation and (e) mother's/guardian's occupation. Occupation was standardized using the 1961 Duncan index for determining occupational prestige (U.S. Department of Education, 2004). In research objective one, SES is

broken into four quartiles of lowest, mid to low, mid to high, and highest. In accordance with previous research (e.g., Plank et al., 2005) SES, sex, and race were included as control variables for research objectives two through four. Within the analyses, SES was a continuous variable, sex was dichotomous (i.e., 0 = male; 1 = female), and race was categorical.

Findings

In total, students in the sample enrolled in public schools included slightly more females (*f* = 4,750; 50.13%) than males (*f* = 4,730; 49.87%). A slight majority of females was also observed within public schools not offering SBAE and for students in public schools where SBAE was offered, but they did not enroll (see Table 1). For students enrolled in SBAE at a public school, the majority were male (*f* = 550; 60.90%). Additionally, students in SBAE included a comparatively higher proportion of white (*f* = 610; 70.83%), Hispanic (*f* = 120; 13.89%), American Indian/Alaska Native (*f* = 20; 2.33%), and Native Hawaiian/Pacific Islander (*f* = <10; 0.35%) students. However, a smaller proportion of Black or African American (*f* = 80; 8.98%) and Asian (*f* = 30; 3.62%) students enrolled in SBAE coursework. For socio-economic status (SES), students enrolled in SBAE were from a lower SES when compared to their peers.

Research objective two sought to determine the relationship between SBAE enrollment and high school graduation after accounting for sex, race, and socio-economic status (see Table 2). The logistic regression produced a statistically significant model (x^2 = 37,105.73; *p*-value < .001) that explained 7% of the variance in high school graduation (R^2 = .07). After accounting for sex, race, and SES, enrollment in SBAE was a statistically significant, positive predictor (*B* = .15; *p*-value < .001) of high school graduation. Furthermore, students who enrolled in SBAE were 1.16 times more likely than students who did not enroll in SBAE to graduate from high school (Odds Ratio = 1.16).

Table 1

Sex, Socio-Economic Status, and Race of Respondents

	Public Schools, SBAE Offered			
	Students Enrolled in SBAE	Students Not Enrolled in SBAE	Public Schools, *No* SBAE Offered	All Public Schools
Sex				
Male	550 *(60.90%)*	1,480 *(47.09%)*	2,700 *(49.62%)*	4,730 *(49.87%)*
Female	360 *(39.10%)*	1,660 *(52.91%)*	2,740 *(50.38%)*	4,750 *(50.13%)*
Race				
American Indian/Alaska Native	20 *(2.33%)*	40 *(1.37%)*	60 *(1.08%)*	120 *(1.30%)*
Asian	30 *(3.62%)*	280 *(9.49%)*	740 *(14.44%)*	1,050 *(11.75%)*
Black or African American	80 *(8.98%)*	350 *(11.80%)*	820 *(16.08%)*	1,250 *(13.97%)*
Hispanic	120 *(13.89%)*	390 *(13.07%)*	690 *(13.48%)*	1,200 *(13.38%)*
Native Hawaiian/Pacific Islander	<10 *(0.35%)*	10 *(0.27%)*	20 *(0.35%)*	30 *(0.32%)*
White	610 *(70.83%)*	1,920 *(64.00%)*	2,780 *(54.57%)*	5,300 *(59.28%)*
Socio-Economic Status				
Lowest	130 *(14.41%)*	360 *(11.51%)*	490 *(9.06%)*	980 *(10.38%)*
Mid to Low	490 *(54.41%)*	1,340 *(43.20%)*	2,180 *(40.42%)*	4,010 *(42.67%)*
Mid to High	260 *(29.27%)*	1,190 *(38.15%)*	2,240 *(41.63%)*	3,690 *(39.30%)*
Highest	20 *(1.90%)*	220 *(7.14%)*	480 *(8.89%)*	720 *(7.65%)*

Note. All frequencies rounded to the nearest 10, per IES restricted-use guidelines.

Table 2

Relationship between SBAE Enrollment and High School Graduation

	Dependent Variable: High School Graduation			
	B	*SEB*	Odds Ratio	*p*-value
Sex	.54	.01	1.71	<.001
Race	.01	.01	0.99	<.001
Socio-Economic Status	.79	.01	2.21	<.001
Enrolled in SBAE	.15	.01	1.16	<.001

Note. R^2 = .07, Chi-Squared = 37,105.73, *p*-value < .001. Enrolled in SBAE was measured as an indicator variable for students who completed SBAE credits.

Research objective three, which sought to determine the relationship between SBAE enrollment and STEM achievement, was analyzed using three linear regressions. First, postsecondary GPA in mathematics courses was analyzed in relation to units of SBAE when controlling for sex, race, and SES (see Table 3). The regression analysis was statistically significant (F = 5,990.81; *p*-value <.001) and explained 6% of the variance in postsecondary mathematics GPA (R^2 = .06). After accounting for sex, race, and SES, units in SBAE was a statistically significant, negative predictor (β = -.08; *p* – value < .001) of postsecondary mathematics GPA.

Table 3

Relationship between SBAE Enrollment and GPA in Postsecondary Mathematics Courses

	Dependent Variable: GPA in Postsecondary Mathematics Courses			
	B	*SEB*	β	*p*-value
Sex	.24	.00	.11	<.001
Race	.06	.00	.12	<.001
Socio-Economic Status	.18	.00	.12	<.001
Units in SBAE	-.11	.00	-.08	<.001

Note. R = .23, R^2 = .06, F = 5,990.81, *p*-value < .001.

In addition to using postsecondary GPA in mathematics, we analyzed the postsecondary GPA of students in science using multiple linear regression (see Table 4). The final model was statistically significant (F = 5,933.00; *p*-value < .001) and predicted 5% of the variance in postsecondary science GPA. Units in SBAE was a statistically significant, negative predictor (β = -.02; *p*-value < .001) of postsecondary science GPA.

Table 4

Relationship between SBAE Enrollment and GPA in Postsecondary Science Courses

	Dependent Variable: GPA in Postsecondary Science Courses			
	B	*SEB*	*β*	*p*-value
Sex	.13	.00	.06	<.001
Race	.05	.01	.11	<.001
Socio-Economic Status	.22	.00	.16	<.001
Units in SBAE	-.03	.00	-.02	<.001

Note. $R = .22$, $R^2 = .05$, $F = 5{,}933.00$, p-value < .001.

The third analysis for research objective three included GPA in all postsecondary STEM courses (i.e., including technology and engineering) as the dependent variable (see Table 5). The final model was statistically significant ($F = 12{,}144.22$; p-value < .001) and predicted 8% of the variance in GPA in all postsecondary STEM courses ($R^2 = .08$). After accounting for sex, race, and SES, units in SBAE was a statistically significant, negative predictor ($\beta = -.03$; p-value < .001) of postsecondary STEM GPA.

Table 5

Relationship between SBAE Enrollment and GPA in Postsecondary STEM Courses

	Dependent Variable: GPA in Postsecondary STEM Courses			
	B	*SEB*	*β*	*p*-value
Sex	.25	.00	.12	<.001
Race	.07	.00	.16	<.001
Socio-Economic Status	.22	.00	.15	<.001
Units in SBAE	-.03	.00	-.03	<.001

Note. $R = .28$, $R^2 = .08$, $F = 12{,}144.22$, p-value < .001.

After analyzing the relationships between units in SBAE and GPA in math, science, and STEM coursework using linear regressions, different levels of involvement in SBAE and mean, postsecondary GPA in math, science, and STEM courses were reviewed (see Table 6). Evaluating GPA by levels of SBAE involvement illuminated potential levels of involvement which may have yielded a higher GPA than no involvement in SBAE. Within math, mean GPA with no units of SBAE ($M = 2.64$; $SD = 1.08$) exceeded all levels of SBAE involvement (i.e., the highest GPA for SBAE involvement was for 4.00 to 4.99 Carnegie units; $M = 2.56$; $SD = 1.06$). The same pattern was observed within science, where the GPA icience with no units of SBAE ($M = 2.57$; $SD = 0.98$) exceeded all levels of SBAE involvement (i.e., highest GPA at 4.00 to 4.99 Carnegie units; $M = 2.54$; $SD = 0.87$). Within postsecondary GPA for all STEM courses, students having been enrolled in 4.00 to 4.99 Carnegie units of SBAE ($M = 2.54$; $SD = 0.98$) slightly exceeded the GPA of students not enrolled in SBAE ($M = 2.50$; $SD = 0.97$).

Table 6

Comparison of Units of SBAE and Math, Science, and STEM Post-Secondary GPA

Units of SBAE	Mathematics GPA			Science GPA			STEM GPA		
	f	*M*	*SD*	*f*	*M*	*SD*	*f*	*M*	*SD*
None	371,681	2.64	1.08	410,458	2.57	0.98	516,250	2.50	0.97
0.01 to 0.99	10,014	2.37	1.01	11,403	2.44	1.01	16,949	2.41	0.96
1.00 to 1.99	28,441	2.32	1.18	27,922	2.42	1.08	42,969	2.27	1.12
2.00 to 2.99	11,885	2.37	1.20	15,013	2.42	1.03	21,202	2.17	1.09
3.00 to 3.99	7,243	2.22	1.15	8,886	2.16	1.05	11,992	2.30	0.98
4.00 to 4.99	6,778	2.56	1.06	7,604	2.54	0.87	9,321	2.54	0.98
5.00 or more	1,906	1.75	1.32	2,792	2.49	0.74	3,483	2.30	0.95

Note. Frequencies provided reflect weighted data.

In the fourth research objective, focus transitioned from academics (i.e., graduation and postsecondary GPA) to labor market outcomes, specifically income. First, the relationship between units in SBAE and the 2011 income of high school graduates (see Table 7) and postsecondary graduates (see Table 8) were explored separately due to differences in earning potential among the two groups. For high school graduates who did not pursue postsecondary schooling, the model with sex, race, SES, and units in SBAE was statistically significant (F = 5,767.09; p-value < .001) and predicted 17% of the variance in income (R^2 = .17). When accounting for sex, race, and SES, units in SBAE was a statistically significant, positive predictor (β = .10; p-value < .001) of 2011 income. Using the unstandardized beta (i.e., B), a one Carnegie unit increase in SBAE enrollment was related to $1,850.67 more in 2011 income.

Table 7

Relationship between SBAE Enrollment and Income for High School Graduates

	Dependent Variable: Income in 2011			
	B	*SEB*	*β*	*p*-value
Sex	-14,908.10	11.57	-.38	<.001
Race	935.24	24.80	.11	<.001
Socio-Economic Status	-313.04	95.54	-.01	.001
Units in Agricultural Education	1,850.67	51.53	.10	<.001

Note. $R = .41$, $R^2 = .17$, $F = 5{,}767.09$, p-value < .001.

Similar to the previous analysis, 2011 income for postsecondary graduates was analyzed in a regression with sex, race, SES, and units in SBAE (see Table 8). The model was statistically significant ($F = 11{,}118.79$; p-value < .001) and predicted 6% of the variance in 2011 income for postsecondary graduates ($R^2 = .06$). After accounting for sex, race, and SES, units in SBAE was a statistically significant, positive predictor ($\beta = .02$; p-value < .001) of income among postsecondary graduates. Furthermore, an additional Carnegie unit of SBAE was related to an additional $457.40 in 2011 income.

Table 8

Relationship between SBAE Enrollment and Income for Postsecondary Graduates

	Dependent Variable: Income in 2011			
	B	*SEB*	*β*	*p*-value
Sex	-8,944.55	54.06	-.19	<.001
Race	570.01	13.11	.05	<.001
Socio-Economic Status	3,740.27	39.75	.11	<.001
Units in Agricultural Education	457.40	30.82	.02	<.001

Note. $R = .24$, $R^2 = .06$, $F = 11{,}118.79$, p-value < .001.

In addition to exploring the relationship between involvement in SBAE and income using linear regressions, the mean 2011 income for varying levels of enrollment was analyzed (see Table 9). For high school graduates, five of the six levels of SBAE enrollment (i.e., 1.00 to 1.99, 2.00 to 2.99, 3.00 to 3.99, 4.00 to 4.99, and more than 5.00 units of SBAE) exceeded the income of individuals who did not enroll in SBAE ($M = 19{,}307.43$; $SD = 18{,}097.71$) with the starkest difference illustrating students who enrolled in 4.00 to 4.99 Carnegie units of SBAE ($M = 31{,}248.58$; $SD = 20{,}317.49$) made $11,951.15 more in 2011 than students who did not enroll in SBAE. For post-secondary graduates, three of the six levels of SBAE enrollment (i.e., 3.00 to 3.99, 4.00 to 4.99, and more than 5.00 units of SBAE) yielded a higher 2011 income than students who did not enroll in SBAE ($M = 26{,}384.15$; $SD = 23{,}854.15$) with the starkest difference showcasing students who enrolled in more than 5.00 Carnegie units of SBAE ($M = 35{,}031.05$; $SD = 18{,}408.24$) earned $8,646.06 more than students who did not enroll in SBAE.

Table 9

Comparison of Units of SBAE and Income

Units of SBAE	High School Graduate, No Post-Secondary			Post-Secondary Diploma		
	f	*M*	*SD*	*f*	*M*	*SD*
None	87,112	19,307.43	18,097.71	624,326	26,384.99	23,854.15
0.01 to 0.99	6,763	16,875.94	17,472.04	28,958	21,042.59	21,214.93
1.00 to 1.99	15,422	26,434.82	26,101.01	60,289	25,490.53	22,639.83
2.00 to 2.99	9,071	29,066.12	21,093.75	30,467	26,051.52	19,194.21
3.00 to 3.99	2,128	27,206.06	11,557.69	14,516	32,029.89	21,882.01
4.00 to 4.99	1,707	31,248.58	20,317.49	11,112	31,084.94	18,620.81
5.00 or more	1,130	25,750.47	10,504.23	4,294	35,031.05	18,408.24

Note. Frequencies provided reflect weighted data.

Conclusions and Discussion

A goal of the current study was to spark informed conversations about the status and future directions of SBAE. Therefore, the conclusions and discussions are purposefully designed to initiate conversations by introducing readers to pivotal questions emerging from the results of the current study. Before moving forward, however, we must address two limitations. First, data collection began in 2002 and concluded in 2012, with final results available in 2015. Given the timeframe and the continual evolution of education, society, and SBAE, the current picture may vary from the findings. Unfortunately, longitudinal research takes time, and given the many years needed to collect data, we will not realize any more nationally representative data of this scale for some time. Second, analyses of the research objectives yielded limited explanatory power (i.e., r^2 values ranged from .05 to .17). Human achievement is the product of complex networks of variables (e.g., location, personality, professional networks) not considered in the current study, which explain the unaccounted variances. When formulating the discussion, identified limitations were taken into consideration with purposeful focus on practically significant results and discussions to illuminate how data collected from 2002 to 2012 inform current and future practices in SBAE.

Question 1: Recruiting Black and Asian Students

Comparing the demographics of respondents enrolled in public high schools illuminates a lower proportion of Black and Asian students in SBAE courses. Previously, limited minority enrollment in SBAE may have been rationalized by pointing to the higher proportion of SBAE programs in rural, largely white communities. However, these data illustrate when Black and Asian students have the option to enroll in SBAE, they do so at a lower rate than their peers. The missing perspectives of Black and Asian students has the potential to weaken SBAE and could be a contributing factor to less diversity within professional agriculture, food, and natural resource (AFNR) sectors. Within SBAE, conversations must begin to answer - *what should we be doing to engage more Black and Asian students?*

As a profession, SBAE must act with purpose and intention to understand the reduced enrollment of Black and Asian students. To provide direction, the decisions of Black and Asian

students to enroll, or not enroll in SBAE should be considered from an ecological systems perspective. Specifically, analysis should be done at the microsystem and macrosystem levels. At the microsystem level, efforts should explore the influence of teacher to student, student to peer, and student to SBAE program interactions to identify potential roadblocks to Black and Asian student enrollment. Additionally, efforts should explore the macrosystem level; specifically, research into the intersections of Black and Asian culture, agriculture, and SBAE. Research will be necessary to address these potential influencers on a broader scale. However, we recommend SBAE programs and teacher education programs evaluate the content, culture, and norms of focus and how current programmatic foci influence recruitment of Black and Asian students. As a product of research and programmatic evaluations, we look forward to a collective conversation in SBAE regarding areas for improvement as well as current areas of strength with regard to recruiting Black and Asian students.

Question 2: Evaluating STEM Learning in SBAE

In an effort to understand the relationship between SBAE enrollment and STEM learning, the relationship between units of SBAE and postsecondary math, science, and STEM GPA were analyzed. First, we recognize the limitations of this analysis; specifically, the potential evolution of SBAE since 2002 with regard to STEM education; the potential variations in postsecondary institutions, courses, instructors, and grading processes; and individual student factors which may have influenced our analyses. Acknowledging those limitations, findings from this research provided no evidence SBAE enrollment was related to increased math, science, or STEM GPA at the postsecondary level. In fact, evidence emerged linking increased SBAE coursework to reduced math, science, and postsecondary STEM GPA. Importantly, these findings are not the first to suggest SBAE does not improve measurable STEM achievement (Connors & Elliot, 1995; Despain et al., 2016; Israel et al., 2012; Nolin & Parr, 2013)

Initially, findings may cause concern regarding the impact of SBAE enrollment on STEM learning; however, we believe findings illuminate a chasm between the envisioned role of SBAE in STEM and the way STEM learning is evaluated. Throughout the history of the discipline, SBAE has claimed teaching agriculture, food, and natural resources (AFNR) *contextualized* STEM concepts. However, research into the STEM learning of students in SBAE consistently uses *decontextualized* STEM achievement as the outcome of interest. Within the current study, postsecondary STEM GPA was considered as an indicator of STEM achievement. While dependent on institution, course, and instructor, postsecondary STEM courses rarely contextualize concepts within AFNR; therefore, as others before us, we used a decontextualized outcome to measure a contextualized approach to STEM learning. Within SBAE, conversations must begin to answer – *what must change to better connect the STEM learning approach of SBAE to the way we evaluate STEM knowledge?*

Connecting practice and evaluation is critical for the continued evolution of STEM and AFNR learning. To link practice and evaluation, two approaches should be considered: (a) re-conceptualize the role of SBAE as a method through which students learn *decontextualized* STEM concepts or (b) develop new methods to evaluate *contextualized* STEM knowledge and skills. Recognizing the critical importance of AFNR knowledge and skills as well as the ethos of SBAE (i.e., to build AFNR knowledge) we encourage maintaining the contextualized STEM education approach in combination with the development, and use, of new evaluation methods focused on contextualized STEM knowledge and skills.

Question 3: Positioning AFNR for Future Success

In the current study, three potential outcomes of student enrollment in SBAE (i.e., graduation, STEM achievement, and income) were considered. As discussed, no evidence emerged linking SBAE enrollment and STEM achievement. However, evidence suggested SBAE enrollment was related to increased graduation rates and higher incomes. The positive relationship between SBAE and graduation rates supports existing literature identifying a positive relationship between CTE and graduation (Plank, 2001; Plank et al., 2005). Likewise, the positive relationship between SBAE enrollment and income supports existing research evaluating CTE enrollment and income (Bishop & Mane, 2004; Haung & Gray, 1992).

First, and foremost, findings provide an exciting foundation for marketing current and future SBAE programs. Specifically, marketing information should highlight three findings, (a) students who enrolled in SBAE were 1.16 times more likely to graduate high school than students who did not enroll in SBAE, (b) each additional Carnegie unit (i.e., one course, one period a day, for one year) of SBAE enrollment was related to $1,850.67 more in annual income among high school graduates, and (c) each additional Carnegie unit of SBAE enrollment was related to $457.40 more in annual income among postsecondary graduates. Second, findings, especially when juxtaposed with those of STEM achievement, provide an opportunity to reflect on, and discuss, – *what disciplinary foci best positions SBAE for future relevance and an enhanced impact on students?*

In 1988, the focus of SBAE transitioned from vocational preparation to STEM (i.e., emphasizing science) knowledge building (McKim et al., 2017). This transition was a critical maneuver to ensure the continued relevance of the discipline in light of social pressure on education to focus on core academic subjects. However, the findings from the current study do not appear to support this transition. In fact, graduation rates and income (i.e., two areas positively associated with SBAE enrollment) are more closely aligned outcomes of vocational preparation than STEM achievement (i.e., the one area negatively associated with SBAE enrollment). For the SBAE discipline to increase in relevance and positive student impact, which outcome(s) should the discipline strive for? Should SBAE continue to push STEM learning with the hope of measureable student success? Should SBAE return to its vocational roots, marketing the discipline as a way to enhance graduation rates and the professional earning potential of students? Should SBAE attempt to combine goals, seeking to enhance STEM learning and vocational development? Is there a new outcome (e.g., ecological problem solving, leadership, social equity) which would better propel SBAE in an enhanced direction? Engaging in conversations around potential future directions is a challenging, yet valuable, endeavor.

Answering unanswered questions often provides a foundation to ask more questions. In this study, we sought to pose challenging questions. Engaging in the self-reflection and critical conversations required to answer the questions may at times prove difficult. However, progression as a discipline depends on the collective willingness of SBAE professionals, at all levels, to address these challenging questions with a commitment to better the experience of SBAE students, today and tomorrow.

References

Alliance for Excellence in Education (2010). *High school dropouts in America.* Factsheet, September 2010. Washington, DC: Alliance for Excellence in Education. Retrieved from http://all4ed.org/wp-content/uploads/HighSchoolDropouts.pdf

Bishop, J. H., & Mane, F. (2004). The impacts of career-technical education on high school labor market success. *Economics of Education Review, 23*(4), 381-402. doi:10.1016/j.econedurev.2004.04.001

Bridgeland, J.M., DiIulio, J. & Morison, K. B. (2006) *The Silent Epidemic: Perspectives of High School Dropouts*, A report by Civic Enterprises in association with the Peter D. Hart Research Associates (Washington, DC: March 2006).

Brigman, G.A. & Campbell, C. (2003) Helping students improve academic achievement and school success behavior. Professional School Counseling, 7(2), pp. 91-98.

Bronfenbrenner, U. (1993). The ecology of cognitive development: Research models and fugitive findings. In R. H. Wozniak & K. Fischer (Eds.), *Development in context: Acting and thinking in specific environments* (pp. 3-44). Hillsdale, NJ: Erlbaum.

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., & Elliot, J. (1995). The influence of agriscience and natural resources curriculum on students' science achievement scores. *Journal of Agricultural Education, 36*(3), 57-63. doi:10.5032/jae.1995.03057

Crain, R., Allen, A., Thaler, R., Sullivan, D., Zellman, G., Little, J., & Quigley, D.. (1999). *The effects of academic career magnet education on high schools and their graduates.* Berkeley, Calif.: University of California, National Center for Research in Vocational Education.

Croom, D. B. (2008). The development of the integrated three-componenet model of agricultural education. *Journal of Agricultural Education, 49*(1), 110-120. doi:10.5032/jae.2008.01110

Dahir, C.A. & Stone, C.B. (2003) Accountability a M.E.A.S.U.R.E of the impact school counselors have on student achievement. *Professional School Counseling, 6*(3), 214-220.

Davalos, D. B., Chavez, E. L., & Guardiola, R. J. (1999). The effects of extracurricular activity, ethnic identification, and perception of school on student dropout rates. *Hispanic Journal of Behavioral Sciences, 21*(1), 61-77. doi:10.1177/0739986399211005

Despain, D., North, T., Warnick, B. K., & Baggaley, J. (2016). Biology in the agriculture classroom: A descriptive comparative study. *Journal of Agricultural Education, 57*(1), 194-211. doi:10.5032/jae.2016.01194

Federal Student Aid Information Center (FSAIC) (2011). *The guide to federal student aid.* Washington: FSAIC.

Goldschmidt, P., & Wang, J. (1999). When can schools affect dropout behavior? A longitudinal multilevel analysis. *American Educational Research Journal*, *36*(4), 715-738. doi:10.3102/00028312036004715

Gray, K. (2004). Is high school career and technical education obsolete? *Phi Delta Kappan*, *86*(2), 128-134.

Gysbers, N.C. & Lapan, R.T. (2001) The implementation and evaluation of a comprehensive school guidance programs in the United States: Progress and prospects. *International Journal for Vocational Guidance, 1*(1), 197-208.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2006). *Multi-variate data analysis.* Prentice Hall; Upper Saddle, NJ.

Hayes, R. L., Nelson, J. L., Tabin, M., Pearson, G., & Worthy, C. (2002). Using school-wide data to advocate for student success. *Professional School Counseling, 6*(2), 86-94.

Huang, N. T., & Gray, K. (1992). Sub-Baccalaureate Postsecondary Education: Does It Pay Off for Vocational Education Graduates? *Journal of Industrial Teacher Education, 29*(3), 9-20.

Israel, G., Myers, B., Lamm, A., & Galindo-Gonzalez, S. (2012). CTE Students and Science Achievement: Does Type of Coursework and Occupational Cluster Matter? *Career and Technical Education Research, 37*(1), 3-20. doi:10.5328/cter37.1.

Lerner, R. M. (1995). *America's youth in crisis: Challenges and options for programs and policies.* Thousand Oaks, CA: Sage

Mahoney, J. L., & Cairns, R. B. (1997). Do extracurricular activities protect against early school dropout? *Developmental Psychology, 33*(2), 241. doi:10.1037/0012-1649.33.2.241

Martin, E. J., Tobin, T. J., & Sugai, G. M. (2003). Current information on dropout prevention: Ideas from practitioners and the literature. *Preventing School Failure: Alternative Education for Children and Youth, 47*(1), 10-17. doi:10.1080/10459880309604423

McKim, A. J., Velez, J. J., Lambert, M. D., & Balschweid, M. A., (2016). A philosophical review of science and society within Agricultural Education. *Journal of Agricultural Education, 58*(2), 98-110. doi: 10.5032/jae.2017.02098

Muennig, P. (2007). How education produces health: a hypothetical framework. *Teachers College Record*. Retrieved from http://www.tcrecord.org/content.asp?contentid=14606

National Center for Educational Statistics. (2002). *Educational Longitudinal Study: 2002-2012* [Data file and code book]. Retrieved from https://nces.ed.gov/surveys/els2002

Nolin, J. B., & Parr, B. (2013). Utilization of a high stakes high school graduation exam to assess the impact of agricultural education: A measure of curriculum integration. *Journal of Agricultural Education, 54*(3), 41-53. doi:10.5032/jae.2013.03041

Okou, J. E. (2004). *Academic and transitional experiences of high school at-risk youth* (Doctoral dissertation, The Pennsylvania State University).

Plank, S. (2001). *Career and technical education in the balance: An analysis of high school persistence, academic achievement, and postsecondary destinations*. St. Paul, MN: National Research Center for Career and Technical Education, University of Minnesota.

Plank, S., DeLuca, S., & Estacion, A. (2005). Dropping Out of High School and the Place of Career and Technical Education: A Survival Analysis of Surviving High School. *National Research Center for Career and Technical Education*.

Ricketts, J. C., Duncan, D. W., & Peake, J. B. (2006). Science achievement of high school students in complete programs of agriscience education. *Journal of Agricultural Education, 47*(2), 48-55. doi:10.5032/jae.2006.02048

Ross, G. A. (2001). *Comparison of grading performance of agriscience students to non agriscience students in upper level science classes at McEwen High School* (Master's thesis, Middle Tennessee State University).

Rumberger, R. W. (1995). Dropping out of middle school: A multilevel analysis of students and schools. *American Educational Research journal, 32*(3), 583-625. doi:10.3102/00028312032003583

Rumberger, R. W., & Larson, K. A. (1998). Student mobility and the increased risk of high school dropout. *American Journal of Education, 107*(1), 1-35. doi:10.1086/44420

Silverberg, M., Warner, E., Fong, M., & Goodwin, D. (2004). *National Assessment of Vocational Education.* Final Report to Congress. US Department of Education. Washington, DC.

Stone, J., Alfred, C., Pearson, D., Lewis, M., & Jensen, S. (2006). *Building academic skills in context: Testing the value of enhanced Math learning in CTE.* Retrieved from http://www.nrccte.org/resources/publications/building-academic-skills-context-testing-value-enhanced-math-learning-cte

Swanson, C. B., & Schneider, B. (1999). Students on the move: Residential and educational mobility in America's schools. *Sociology of Education, 72*(1), 54-67. doi:10.2307/2673186

Theriot, P. J., & Kotrlik, J. W. (2009). Effect of enrollment in agriscience on students' performance in science on the high school graduation test. *Journal of Agricultural Education, 50*(4), 72-85. doi:10.5032/jae.2009.04072

U.S. Department of Education, National Center for Education Statistics. (2004). *Education Longitudinal Study of 2002: Base Year Data File User's Manual*, NCES 2004-405, by Steven J. Ingels, Daniel J. Pratt, James E. Rogers, Peter H. Siegel, and Ellen S. Stutts. Project Officer: Jeffrey A. Owings: Washington, DC.