Journal of Agricultural Education, 65(3), 1-17
https://doi.org/10.5032/jae.v65i3.123

Evaluating the Influence of Single-Sex Secondary Agriculture Classrooms on Student Career Interests

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Abstract

Single-sex classrooms have been a topic of interest in the educational community since the No Child Left Behind Act of 2001. The academic achievement gap between boys and girls in high school is a complex and multifaceted issue that has garnered significant attention in educational research. Proponents of single-sex classrooms argue that it reduces social anxiety, physical aggression, and can close the achievement gap between boys and girls. This quasi-experimental study compared students in single-sex classrooms and coeducational classrooms of ten various Principles of Agriculture courses in Kentucky, and the influence these teaching models had on students' career interests. Key findings from this experimental study included: (a) boys in single-sex classrooms ranked their interest in the agriculture, food, and natural resources career pathway the highest; (b) the classroom structure nor the sex of the students were not influential to the gain in students interest in the agriculture, food, and environment careers; (c) boys and girls in single-sex classroom structures were influenced more than their coeducational classroom colleagues in a career interest in education and training, particularly, agricultural education. Recommendations from this study include: (a) exposing boys to careers in agricultural education early in high school; (b) prepare teachers on methodologies that limit gender stereotypes within the agriculture career field; and (c) the need for study replication along with longitudinal and qualitative research.

Introduction

Experts continue to weigh in on whether single-sex classrooms have a place in the United States' public-school system. Recent amendments to educational policy have resurfaced an unsettled debate among educators, researchers, and policymakers on the effectiveness of these learning environments (Klein et al., 2014). In response, researchers have attempted to resolve this debate with support from empirical evidence. However, methodological limitations, primarily the inability to randomize samples in public schools, have prevented a clear resolution.

Coincidingly, educational administrators have increased their implementation of single-sex classrooms in the hope to improve the academic performance (Klein et al., 2014). Advocates for single-sex classrooms argue that such learning environments help reduce the national achievement gap between boys and girls (Gurian et al., 2009), empower youth by reducing stereotypes (Bowe et al., 2015), reduce social anxieties (Hart, 2016), and decrease physical aggression in adolescents (Dijkstra & Berger, 2017). These beliefs are primarily based through the lens of the biological differences perspective that suggests males and females have biological differences that need specialized attention. In educational settings, single-sex classrooms allow instructors to address these biological differences by adjusting their pedagogy (Sax, 2017).

Arguments against single-sex classrooms emphasize the similarities between boys and girls. Supporters of coeducational designs claim that gendered differences are small or nonexistent (Pahlke et al.,

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2014). Moreover, structures of sex segregation are argued to hinder academic performance (Legewie & DiPrete, 2012), promote gendered stereotypes (Fabes et al., 2013), and may have severe cross-gender relationship outcomes such as gender-based violence, harassment, and bullying (Hunt & Gonsalkorale, 2014).

Consequently, the deliberation among scholars continues to inform teaching practices, improve academic performance, and reduce gendered stereotypes. Critically evaluating the outcomes of single-sex classrooms is important to determine the future direction of public education in the United States. Much of the research on single-sex classrooms has focused on the academic performance of students enrolled in single-sex classrooms compared to coeducational classrooms. Less research has directly evaluated the effectiveness of these outcomes in public school settings, and even less literature is available for studies that controlled for selection effects (Pahlke et al., 2014).

This study attempted to address the ongoing debate on the effectiveness of single-sex classrooms in public schools, particularly in agricultural education. Addressing these discrepancies in the literature is important because there is a growing need for policymakers, administrators, teacher educators, scholars, and teachers to find solutions to improve students' academic performance.

Conceptual/Theoretical Framework & Literature Review

Gender schema refers to the mental structures that organize incoming information according to gender categories (Bem, 1981). Children determine the in-groups and out-groups in which they learn social dichotomies according to their biological sex. Once an identity is acquired, they can understand information as it applies to their own group (Priess & Hyde, 2010). Priess and Hyde (2010) posit that people organize and remember information according to their sex and are more likely to prefer activities, classes, hobbies, and extracurriculars associated with their own sexual identity. As discussion of gender issues becomes more mainstream in society, the differentiation between the terms sex and gender has emerged and is evolving. Sex refers to one's biological characteristics that distinguish male and female individuals, while gender is more complex as it is a socially and culturally constructed identity (Muehlenhard & Peterson, 2011). In this context, sex is a binary classification between male and female, whereas gender is a nonbinary continuum between masculinity and femininity (Lindsey, 2015). Although some people believe that one's biological sex dictates their gender, Lindsey (2015) declared the widely accepted notion that one's sex does not necessarily determine one's gender. Few would argue that gender is influenced by social and environmental factors. The formations of gender may begin early in a child's development. As early as age two, children can dictate differences in gender and by age three children begin to believe their sex cannot change (Woolfolk & Usher, 2018). By age four, children prefer to spend more time, approximately three times as much, with single-sex friends; at age six, preference to single-sex friendships grow to 11:1 (Halim et al., 2013). Scholars suggest that as children age, they are exposed to more sociocultural factors and influences. According to Woolfolk and Usher (2018), children begin to understand what it means to be male or female through a complex network of knowledge, or gender schemas.

As boys and girls develop, they begin to form an understanding of gender roles and conceptualize appropriate behaviors and attitudes to fulfill what it means to be "masculine" or "feminine." These notions often rely on broad stereotypes. Aronson and Steele (2005) described stereotypes as "pictures in our heads," simplified expectations of abilities, behaviors, intelligence, and more, influenced by gender bias. Woolfolk and Perry (2015) suggested that stereotypes and gender roles are rigid and challenging to change, particularly in defining what is socially acceptable as masculine or feminine, such as certain career choices.

Teachers also play a significant role in shaping children's understanding of gender. Gansen (2017), drawing from ethnographic data collected over ten months in preschool classrooms, argued that teachers both construct and occasionally disrupt gendered norms. Gansen highlighted that even in preschool settings,

teachers contribute to heteronormativity—the belief that heterosexuality is the norm, appropriate, and privileged—thereby perpetuating gender biases in the classroom. Such biases can manifest subtly through choices like classroom decor, reading materials, and the use of gendered pronouns (Brown & Stone, 2016).

Gender bias, which often favors hegemonic norms, isn't always advantageous for boys. Some researchers argue that current educational pedagogy, methodologies, and learning environments contribute to the national underachievement of boys. Scholars have identified the academic performance of boys as "one of the most pressing educational equality challenges of current times" (Hartley & Sutton, 2013, p. 1716). Recent discussions among scholars have also highlighted anecdotal beliefs about boys assuming fewer student leadership roles within agricultural youth organizations (Meyers, 2018), potentially influencing youth engagement in agriculture-related careers. Interestingly, colleges of agriculture are observing a decline in male enrollment preparing for post-secondary careers in the field (Conger & Long, 2010).

As such, implications from gender studies serve as possible enhancements in teaching practice. Woolfolk and Usher (2018) suggested these biases were often unintended and teachers are not aware of their subconscious, implicit behavior. For instance, the way teachers group students, response opportunity may be given to one sex over the other, and gendered speech are some of the ways teachers demonstrate gender bias without realizing it. In science laboratories, scholars found that when teachers grouped students without purposively assigned responsibilities the "girls end up as secretaries, boys as technicians" (Woolfolk & Usher, 2018, p. 246). As a result, male students gain more skill development in science than their female student counterparts.

The perspective that teachers play a significant role in safeguarding student equality appears undisputed. However, the ongoing influence of their gender beliefs on students' development into young men and women requires further exploration. Much work remains to understand how teachers may provide different experiences to students of different genders.

Newsom-Stewart and Sutphin (1994) found that girls and boys held differing perceptions about agricultural education and called for further investigations that "examine cultural and gender differences" in SBAE (p. 55). Their recommendation for future research spurred studies that investigated the effects of gender on student achievement (Johnson et al., 1998), students' rationale for course selection (Sutphin & Newsom-Stewart, 1995), and the emergence of girls in leadership roles (Ricketts et al., 2004). Over 25 years after Newsom-Stewart and Sutphin's introductory study on gender dynamic, literature in SBAE still remains scarce in gender studies and gender related issues (Enns & Martin, 2015). In the meantime, a supply and demand study reflect a significant difference in male and female student enrollment in agricultural education (Lawver, et al., 2018) while Tingle (2017) recognized how legislation, curriculum, recruitment efforts, and economic factors created cultural and structural changes that effected the male and female enrollment in agricultural education between 2009-2014.

Purpose of the Study

The purpose of this nonequivalent comparison group, quasi-experiment was to evaluate the effectiveness of single-sex classrooms on student career aspirations. The independent variable in this study was the manipulation of learning environments within *Principles of Agriculture* courses by mediating the composition of classrooms to either single-sex classrooms (treatment; X+) or coeducational classrooms (control; X-). Analyses between X+ and X- were conducted along with analyses between the four levels of the independent variable: $X+_1$ (boys in treatment group), $X+_2$ (girls in treatment group), $X-_1$ (boys in control group), and $X-_2$ (girls in the control group). The dependent variables included general career interest and agricultural career interest. The following research objectives and hypotheses guided the scope of the study:

RO1: Examine student interest of $X+_1$, $X+_2$, $X-_1$, and $X-_2$ in 16 career pathways.
RO2: Examine student interest of $X+_1$, $X+_2$, $X-_1$, and $X-_2$ in 8 agriculture career pathways

$H_0$1: Students enrolled in single sex classrooms (treatment) will have more interest in the a) agriculture, food and environment and b) education and training, than students enrolled in coeducational classroom (control) settings.
$H_0$2: Students enrolled in single sex classrooms (treatment) will have more interest in the eight agricultural career pathway interest areas than students enrolled in coeducational classroom (control) settings.
$H_0$3: The agriculture, food, and environment career interests is not influenced by the classroom setting (single-sex; coeducational) and sex of the student (male; female).
$H_0$4: The education and training career interests is not influenced by the classroom setting (single-sex; coeducational) and sex of the student (male; female).
$H_0$5: The career interest in agricultural education is not influenced by the classroom setting (single-sex; coeducational) and sex of the student (male; female).

Methodology

The untreated control group design with dependent assessments (Shadish et al., 2002), frequently called the nonequivalent comparison group design, was utilized in this study. This quasi-experimental design is recommended in educational field research for ethical, practical, and legal reasons (Steiner et al., 2009).

The intervention for this quasi-experiment was separating the *Principles of Agriculture* courses in homogenous, single-sex classrooms. The intervention was randomly assigned to three of the five selected schools to form the treatment group (Group A) following a selection protocol for participating schools. The following table explains the random assignment:

Table 1

Control and Treatment Classroom Assignment

Subgroup Identity	Enrollment Identity	Teacher Identity	*n*	*# of Schools*
Group A-boys ($X+_1$)	Male	Male	68	4
Group A-girls ($X+_2$)	Female	Female	76	4
Group B-boys ($X-_1$)	Male	Male & Female	21	2
Group B-girls ($X-_2$)	Female	Male & Female	26	2

The intervention lasted the fall semester of the 2019 school year, a total of 15-weeks. No other intervention was provided. All instructors taught the *Principles of Agriculture* course to the state's course standards. The only manipulated difference between the groups was the composition of biological sex in the classroom. Biological sex was determined as the dyadic area being compared versus gender which is socially constructed and cannot be disseminated into a dyadic comparable group (Lips, 2020). Both groups were administered a pretest and posttest.

The assessment of threats to internal validity, also known as ambiguous temporal precedence (Shadish et al., 2002), was a critical methodological approach for a quasi-experimental design (Cook & Steiner, 2010; Creswell & Creswell, 2018; Martin & Bridgmon, 2012). Actions were taken in this study to minimize potential threats to internal validity. Threats to internal validity (Bell & Stuart, 2016) addressed

in the design included history (treatment and control were subject to the same time frame), maturation (participants were similar in age), regression to the mean (participants were from public schools and had similar ability levels), participant selection (treatment groups were randomly assigned), study attrition (school administration provided letters of support to prevent attrition), and diffusion of treatment (Control group was located at a different school). Internal validity assessed whether the dependent variables (outcomes) were indeed causal to the manipulated independent variable (treatment) (Martin & Bridgmon, 2012).

Inclusion and exclusion criteria were used to recruit a study sample with certain characteristics and control for extraneous variables (Creswell & Creswell, 2018). Inclusion criterion was implemented to recruit a sample that shared the following characteristics:

1. The school was located in Kentucky;
2. The secondary agriscience department had a minimum of two teachers;
3. The school had a minimum of one male instructor and one female instructor certified to teach secondary agriculture;
4. Both teachers were willing to teach a *Principles of Agriculture* course to the standards set by the Kentucky Department of Education;
5. The school provided a minimum of three *Principles of Agriculture* course for students/parents who may not consent to participate.

Forty-three schools met the inclusion criteria and were contacted via email for recruitment purposes. Following this, two subsequent follow-up emails were sent within a month by a respected faculty member known among the teachers. Ultimately, 10 schools expressed interest in participating. However, two schools withdrew due to uncertainties regarding enrollment and course offerings. By December, eight schools confirmed their willingness and ability to participate and were requested to obtain formal school consent. By January, seven schools provided written approval from their administration. In January, teachers from six schools ($n = 12$) convened at a central location to discuss the study procedures and random assignment process. Using simple random assignment, four schools were allocated to the treatment group, while three were assigned to the control group. In June, one school from the control group underwent a change in teaching staff, leading to its withdrawal from the study. Consequently, four schools (comprising eight classrooms) formed the treatment group (single-sex classrooms), while two schools (with two classrooms) constituted the control group (coeducational classrooms). Notably, each school was situated in a rural, predominantly Caucasian farming community (Kentucky Department of Education, 2020).

Participants

A total of 191 freshman students enrolled in their first year of high school (14-16 years of age) participated in the study. Of the 191 participants, 102 (53.4%) were female students and 89 (46.6%) were male students. A total of 144 (76 female students, 68 male students) students were placed into single-sex classrooms as the treatment group, and 47 students (26 female students, 21 male students) remained in coeducational classrooms as the control group. Participation in the study was granted by collection of parental permission and student assent within the first two weeks of school. Student participants in the treatment group (single-sex classrooms) had the option to opt-out into a traditional coeducation classroom. Parents also had an option to remove their child and place into a coeducation classroom. No students or parents requested to opt-out of single-sex classrooms.

The school districts reported that of the student participants, 21 (11.3%) had an identified Individualized Education Plan (IEP) or 504 plan and 10 (5.4%) students were considered gifted. Over half of the student participants qualified for free and/or reduced lunch ($f = 95$; 56.4%) and identified as low socio-economic status. Additionally, many of the students were FFA members ($f = 111$; 66.1%). Ethnicity was not collected due to a lack of critical mass representation beyond white/non-Latino.

Students reported the marital status of their biological parents. Respondents indicated that many of their biological parents were not married (*f* = 89; 54.6%). Most of the students (*f* = 84; 51.5%) were unsure about their father's level of education, while many students reported their mother's level of education to be a bachelor's degree (*f* = 89; 16.0%).

The study followed all protocols, confidentiality, and safety measures approved by the university's Institutional Review Board (IRB) for protocol 51555 to protect the rights and welfare of human research subjects.

Measures

Analyses between X+ and X- were conducted along with analyses between the four levels of independent variable: $X+_1$ (boys), $X+_2$ (girls), $X-_1$ (boys), and $X-_2$ (girls). The dependent variables included general career interest and agricultural career interest and was distributed at the end of the academic semester.

A test-retest reliability assessment of the two questionnaires were conducted to evaluate its consistency over time. The researchers asked participants from two non-participating schools to complete the questionnaires on two separate occasions, with a one-month interval between administrations. The correlation coefficient between the scores obtained from the two administrations was calculated to assess the degree of agreement. The Pearson correlation coefficient was found to be $r = 0.85$ for the Career Pathway Interest and $r = 0.88$ for the Agricultural Career Pathway Interest, indicating a strong positive correlation between the responses at the two time points. This suggests that the questionnaire demonstrates high test-retest reliability, with consistent results over time (Kurtz, 2020). Therefore, confidence in the stability and repeatability of the questionnaire's measurements is assumed.

Career Pathway Interest

Career pathway interest was measured by the Career Clusters Interest Survey (Advance CTE, 2005). The survey included 16 items that represented 16 career paths ranging from (1) agriculture, food, and natural resources to (16) transportation, distribution, and logistics. Each item had 17 possible interest statements (seven activities, five personal qualities, and five subjects that relate to the career path). Internal consistency was evaluated by calculating the post-hoc Cronbach alpha ($\alpha = .95$).

Agricultural Career Pathway Interest

Agricultural career pathway interest was measured by the GrowNexGen Agriculture Career Survey (GrowNextGen, 2017). The survey included eight items that represented eight agricultural career pathways, which included agricultural education. Each item had 12 interest statements (four activities, four personal qualities, and four subjects that relate to each career path). Internal consistency was evaluated by the researchers through a test-retest format, calculating the post-hoc Cronbach alpha ($\alpha = .92$).

Data Analysis

Data collected from each student was inputted into IBM Statistical Package for Social Sciences® (SPSS) version 26 for data analysis. The data were organized and cleaned prior to analysis. To determine a difference among the test between the control and treatment groups, a t-test and a factorial ANOVA was implemented (Shieh, 2020). To address the assumptions for each, as recommended by Field (2018), descriptive analyses (e.g., means, standard deviations, skew, kurtosis, histograms) of the data and examined items for normality (Shapiro-Wilk test). The data, using a Levene's test, showed evidence of homogeneity

of variance. To assure that the study addressed outliers, the researchers had to factor the limitation of small sample sizes and unequal group sizes. To address outliers, a robust statistical technique suitable for small samples called the Winsorization method, which involves replacing extreme values with less extreme ones to minimize their influence on the analysis (Hargrave et al., 2023).

Given the small sample size and unequal group size, the researchers acknowledged potential issues with the assumptions of Independence. As a result, the researchers engaged in testing for homogeneity of regression where the pre-assessment of both the career pathway interest and the agriculture pathway interest questionnaires between the control and treatment groups were insignificant with *p* values all at 0.194 or higher; thus, the researchers could move forward by examining the differences between the control and treatment post-results. In the study, multicollinearity was addressed by examining the variance of inflation (VIF) values for all independent variables included in the factorial ANOVA analysis, ensuring that no variables exhibited high levels of correlation that could potentially distort the interpretation of the results.

Findings/Results

To examine student interest of $X+_1$, $X+_2$, $X-_1$, and $X-_2$ in 16 career pathways, means, standard deviations, and ranges were calculated for each career pathway for $X+_1$, $X+_2$, $X-_1$, and $X-_2$ (see Table 2). Boys in the treatment group ($X+_1$) rated **agriculture, food, and natural resources** (M = 6.49; SD = 3.13) as their highest interest area with education and training (M = 4.95; SD = 3.15) being the eighth highest. Girls in the treatment group ($X+_2$) had the highest interest in health science (M = 8.49; SD = 4.11) with education and training (M = 7.70; SD = 3.93) being third and agriculture, food, and natural resources (M = 7.35; SD = 3.68) being fourth. Boys in the control group ($X-_1$) had the highest interest in architecture and construction (M = 7.63; SD = 3.48), with agriculture, food, and natural resources (M = 7.16; SD = 3.20) ranking fourth and education and training (M = 6.63; SD = 4.10) ranking ninth. Girls in the control group ($X-_2$) had the highest interest in human services (M = 7.58; SD = 4.44), with agriculture, food, and natural resources (M = 6.74; SD = 2.88) ranking sixth and education and training (M = 5.89; SD = 2.93) ranking eleventh out of the 16 pathways.

Table 2

Post-Career Pathway Interest

	Treatment (N = 144)						Control (N = 47)					
	Boys (*n* = 68)			Girls (*n* = 76)			Boys (*n* = 21)			Girls (*n* = 26)		
Career Pathway	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range
CC1	6.53	3.28	3-17	7.58	3.62	2-17	7.16	3.22	4-16	6.74	2.88	3-14
CC2	6.44	3.62	1-17	6.24	3.06	1-14	7.63	3.48	5-15	6.89	3.84	1-13
CC3	3.66	3.62	1-17	5.54	4.19	1-16	6.37	4.11	2-15	5.37	3.39	2-15
CC4	4.21	3.28	1-17	5.43	3.06	2-14	6.05	3.45	2-14	5.74	2.62	2-11
CC5	4.98	3.27	2-14	8.08	3.91	3-17	6.63	4.10	3-17	5.89	2.93	2-13
CC6	4.44	3.25	1-15	4.87	2.89	1-12	6.74	3.91	1-13	6.00	3.11	1-11
CC7	4.95	3.70	2-15	6.17	3.55	2-16	6.68	3.04	3-14	6.84	3.55	2-14
CC8	5.30	3.55	1-17	8.49	4.11	3-17	7.58	4.74	2-15	6.37	4.26	3-17
CC9	4.79	3.79	1-17	6.97	4.00	2-17	6.79	3.75	1-13	6.95	4.50	1-13
CC10	4.61	3.56	1-17	8.03	4.37	1-17	7.37	3.90	1-14	7.58	4.44	3-17
CC11	5.20	3.83	1-17	3.83	2.84	1-11	5.79	3.72	1-12	6.05	4.03	1-12
CC12	5.67	4.15	1-17	6.90	3.86	1-17	7.01	3.82	2-16	7.00	3.58	2-13
CC13	5.67	3.76	1-15	5.70	3.14	1-14	5.74	3.06	1-11	6.63	3.50	3-17
CC14	4.95	3.56	1-15	6.11	3.32	2-16	5.68	3.58	1-10	6.09	3.33	2-14

CC15	4.38	3.86	1-15	4.14	3.08	1-12	5.63	3.89	1-13	5.89	3.99	1-13
CC16	5.57	3.96	1-15	6.60	2.99	2-14	6.05	4.65	2-14	6.21	3.71	1-13

Note. CC1 = agriculture, food and natural resources; CC2 = architecture and construction; CC3 = arts, audio/visual technology, and communications; CC4 = business management and administration; CC5 = education and training; CC6= finance, CC7 = government and public administration, CC8 = health science, CC9 = hospitality and tourism; CC10 = human services; CC11 = information technology; CC12 = law, public safety, corrections, and security; CC13 = manufacturing; CC14 = marketing; CC15 = science, technology, engineering, and mathematics; CC16 = transportation, distribution, and logistics. N = 191. Scale from 1-17.

The second research objective sought to examine student interest of $X+_1$, $X+_2$, $X-_1$, and $X-_2$ in eight agriculture career pathways. The eight pathways included (1) animal science, (2) food processing and food science, (3) plant systems and plant science, (4) environmental science and natural resources, (5) global agricultural systems, (6) agribusiness, (7) power, structural, and technical systems, and (8) agricultural education. Table 3 explains the agriculture career interest by groups. Boys in the treatment group ($X+_1$) had the highest interest in agricultural education (M = 5.23; SD = 3.15) and girls in the treatment group ($X+_2$) had agricultural education (M = 5.59; SD = 2.79) as their fourth highest interest. Boys in the control group ($X-_1$) had agricultural education (M = 6.00; SD = 3.16) as fourth highest interest while girls in the control group ($X-_2$) ranked agricultural education (M = 5.33; SD = 3.03) fifth in their areas of interest. Global agricultural systems were the only career interest that ranked in the top three of all groups.

Table 3

Post-Agricultural Career Pathway Interest

	Treatment (N = 144)						Control (N = 47)					
	Boys (n = 68)			Girls (n = 76)			Boys (n = 21)			Girls (n = 26)		
Ag Pathway	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range
ACP1	3.92	2.72	1-11	5.78	2.70	2-13	5.21	2.66	2-10	4.85	2.68	2-11
ACP2	4.02	2.94	1-12	4.57	2.76	1-11	5.21	2.32	2-10	4.89	3.13	1-10
ACP3	4.33	2.76	1-11	4.73	2.72	1-12	4.89	2.47	1-10	4.58	2.65	1-10
ACP4	4.62	2.48	1-11	5.87	2.87	3-16	6.16	2.48	4-12	5.89	2.79	3-12
ACP5	5.02	3.42	1-12	5.73	3.07	2-14	6.32	3.58	1-11	5.61	2.85	1-9
ACP6	4.48	3.34	1-15	4.83	2.95	1-13	5.00	3.06	1-12	5.56	3.63	1-11
ACP7	5.20	2.95	1-12	3.95	2.11	1-10	5.32	2.69	2-11	5.56	4.39	1-13
ACP8	6.00	3.15	1-13	5.78	2.82	2-14	5.04	3.16	3-11	5.33	3.03	1-10

Note. ACP1 = animal science; ACP2 = food processing and food science; ACP3 = plant systems and plant science; ACP4 = environmental science and natural resources; ACP5 = global agricultural systems; ACP6 = agribusiness; ACP7 = power, structural, and technical systems, and ACP8 = agricultural education. N = 191. Scale from 1-15.

Hypothesis 1 sought to determine if the treatment group had a larger gain in the agriculture, food, and environment careers as well as the education and training careers versus the control group. Since both groups had insignificant differences in the pre-study questionnaire, the researchers utilized the post-questionnaire to determine if a gain occurred. The study did not find sufficient evidence to reject the null hypothesis. See Table 4.

Table 4

Treatment and Control Comparison of Career Interest Following Post-Intervention

	Treatment (N = 144)		Control (N = 47)			
Source	*M*	*SD*	*M*	*SD*	*t*	*p*
Agriculture, Food, & Environment	6.98	3.48	6.95	3.02	.057	.48
Education and Training	6.46	3.89	6.26	3.53	2.84	.39

$p \leq .05$

Hypothesis 2 sought to determine if the treatment group had a larger gained interest in the various agriculture career areas versus the control group (see table 5). Since both groups had insignificant differences in the pre-study questionnaire, the researchers utilized the post-questionnaire to determine if a gain occurred. The results from each career interest were not statistically significant, leading to the retention of the null hypothesis.

Table 5

Treatment and Control Comparison of Agriculture Career Interest Following Post-Intervention

	Treatment (N = 144)		Control (N = 47)			
Agriculture Interest	*M*	*SD*	*M*	*SD*	*t*	*p*
Animal Sci	.238	2.56	.367	3.08	.15	.44
Food Sci	.672	2.59	.902	3.18	1.35	.09
Plant Systems	.488	2.30	.609	2.94	.28	.39
Environmental Science	.647	2.46	.878	2.91	1.21	.12
Global System	1.04	2.63	.68	4.13	.88	.19
Agribusiness	Q	3.12	.365	3.48	.89	.19
Ag Mechanics	.516	2.95	.780	4.11	1.42	.08
Ag Education	.603	2.43	.390	3.95	.52	.30

$p \leq .05$

To investigate Hypotheses 3 and 4, the researchers employed a two-way factorial ANOVA, as displayed in Table 6. Within both career interest areas - agriculture, food, and environment, ($F(1, 191) = 7.48$, $p = .01$, partial $\eta^2 = .05$ and observed power = .31) - and education and training, ($F(1, 191) = 33.52$, $p = .01$, partial $\eta^2 = .20$ and observed power = .43), the covariate of career interest at the beginning of the school year significantly influenced participants' subsequent career interest. However, upon adjusting for prior awareness of the career interest, no statistically significant interaction effect was detected between the two independent variables for the agricultural, food, and environment career fields $F(1, 191) = 1.31$, $p = .26$, partial $\eta^2 = .01$. Therefore, null Hypothesis 3 was retained. Conversely, for Hypothesis 4, a statistically significant interaction effect emerged between the two independent variables for the education and training career fields $F(1, 191) = 9.67$, $p = .01$, partial $\eta^2 = .07$. As a result, the researchers rejected null Hypothesis 4 and accepted the alternative hypothesis, indicating that the combination of classroom setting, and student sex does indeed influence students' interest in the education and training career path.

Table 6

Summary of Two-Way Factorial ANOVA Results for Career Interest by Classroom Setting and Sex, With Pretest Knowledge Scores as a Covariate

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Ag, Food, & Environment						
Covariate	1	80.38	80.38	7.48	.01	.05
Treatment	1	4.79	4.79	.45	.51	.00
Sex	1	9.64	9.64	.90	.35	.01
Treatment*Sex	1	14.03	14.03	1.31	.26	.01
Education and Training						
Covariate	1	350.12	350.12	33.59	.01	.20
Treatment	1	1.10	1.10	.11	.75	.01
Sex	1	1.82	1.82	.18	.68	.01
Treatment*Sex	1	100.86	100.86	9.67	.01	.07

$p \leq .05$

For the final Hypothesis, as delineated in Table 7, the covariate of agricultural education career interest at the beginning of the school year significantly influenced participants' subsequent agricultural education career interest ($F(1, 191) = 43.55$, $p = .01$, partial $\eta^2 = 2.44$ and observed power = .51). However, upon adjusting for prior awareness of the agricultural education career interest, a statistically significant interaction effect surfaced between the two independent variables for the agricultural education career field ($F(1, 191) = 3.28$, $p = .05$, partial $\eta^2 = .02$). Thus, the researchers rejected null Hypothesis 5 and accepted the alternative hypothesis, signifying that the combination of classroom setting and student sex indeed impacts students' interest in the agricultural education career path.

Table 7

Summary of Two-Way Factorial ANOVA Results for Agricultural Education Career Interest by Classroom Setting and Sex, With Pretest Knowledge Scores as a Covariate

Source	*df*	*SS*	*MS*	*F*	*p*	η^2
Agricultural Education						
Covariate	1	305.48	305.48	43.55	.01	2.44
Treatment	1	.04	.04	.01	.44	.01
Sex	1	8.79	8.79	1.25	.07	.01
Treatment*Sex	1	23.05	23.05	3.29	.05	.02

$p \leq .05$

Conclusions/Implications/Recommendations

The academic achievement gap between boys and girls in high school is a complex and multifaceted issue that garnered significant attention in educational research (Fortin et al., 2015; Hermann & Kopasz, 2021). The evaluation of the effectiveness of single-sex classrooms in this study can inform decision makers on advantages of different learning environments. Although many scholars have studied single-sex classrooms, few have done so in public school classrooms (Pahlke et. al, 2014).

At the end of the study, boys in the treatment group ($X+_1$) had the highest interest in the agricultural, food, and natural resources career pathway compared to $X+_2$, $X-_1$, and $X-_2$. They also ranked highest in interest level among all 16 career pathways. No other group ($X+_2$, $X-_1$, and $X-_2$) ranked the agricultural,

food, and natural resources pathway as one of their top three career pathways of interest. For X_{-2} (control-girls) the agricultural, food, and natural resources pathway was not in their top five career pathways.

Intriguingly, all four groups (X_{+1}, X_{+2}, X_{-1}, and X_{-2}) ranked the science, technology, engineering, and mathematics (STEM) in the bottom three career pathways of interest. According to Scherer and colleagues (2019), the incorporation of STEM in agricultural curriculum is noted to increase student motivation. However, the findings in this study indicate that freshman students, despite treatment or control, are less interested in the STEM career pathway. Identifying the level of awareness each participant has toward STEM is unknown and may serve as a limitation.

Woolfolk and Perry (2015) found that stereotypes and gender roles are rigid and difficult to change, especially toward what is socially acceptable as a masculine or feminine career. For example, societal beliefs of STEM careers as more appropriate for men have hindered women to enter STEM professions (Dunlap & Barth, 2019). The National Science Foundation (2017) reported only 28.4% of the STEM workforce was comprised by women. Teachers' implicit behavior, or what they unknowingly do, could be contributing to the underrepresentation of women in STEM careers (Woolfolk & Usher, 2018; Brown & Stone, 2016). However, teachers should empower girls to pursue STEM careers by increasing access to role models and mentors (Stout et al., 2011), deconstruct stereotyped casting of STEM as a more appropriate pursuit for boys (Nosek et al., 2009), and increase girls' sense of belonging in STEM (Cheryan et al., 2009).

The secondary teacher participants are recommended to seek assistance in deconstructing stereotypes in careers so that girls and boys are empowered to enter careers without the influence of what is deemed appropriate by teachers and society. Chan (2022) found this to be the case among a significant number of STEM teachers; thus, the assistance may be necessary for all school-based agriculture teachers. If a strategic goal of agricultural education is to incorporate more STEM concepts into the national curricula (Scherer et al., 2019), then providing teacher professional development for the destigmatizing of gender stereotypes in STEM careers is a necessary pursuit of national agricultural educator teacher preparation programs. But first, a need to empirically investigate how to destigmatize gender stereotypes in STEM careers is needed among agricultural education scholars.

Boys (X_{+1}, X_{-1}) ranked agricultural education in their top three agricultural careers of interest. Boys in the treatment group (X_{+1}) displayed higher interest in agricultural education, as they ranked the agricultural education career pathway number one. In comparison, boys in the control group (X_{-1}) ranked agricultural education as their third highest pathway of interest. Girls (X_{+2}, X_{-2}) did not rank agricultural education in their top three agricultural career pathways.

Garter and Swan (2018) advocated that to meet the need of a growing teacher shortage on the state and national level, intentional recruitment efforts were needed. Knight (1988) reported 95% of agriculture teachers in the United States were men. Now, only 29% of agricultural education program completers – those who complete accredited agricultural education teacher preparation program – were men (Smith, et al., 2019). Yet, the results from this study suggest that freshman boys are more interested in the agricultural education career pathway compared to freshman girls.

Teacher preparation programs should initiate recruitment programs that intentionally target boys in their freshman year of high school. Waiting until the senior year to recruit boys to pursue a career in agricultural education may be too late. The researchers do not discount the importance of teacher preparation programs to recruit young women into the profession nor do the researchers find issue with the high number of young women entering the profession. However, the findings of this study suggest that teacher preparation programs may fail to recruit boys who are interested in agricultural education, particularly early in their high school years.

Secondary teachers are encouraged to discuss agricultural career pathways, especially agricultural education, to their students. Intentional integration of agricultural education into the curriculum empowers boys to pursue a career in education by destigmatizing educational careers to boys (Bowe et al., 2015).

Since No Child Left Behind (NCLB), over 1,000 school districts across the United States implemented some degree of single-sex education (Klein et al., 2014). As more public-schools ratify single-sex learning environments it is important for research to determine the effects. Since this study is limited to the SBAE freshmen students in Kentucky, replication in other context will assist in understanding the effects of single-sex classrooms.

The significance of this study was underscored by the call to answer critical methodological issues whereas: (a) quasi-experiential design is utilized; (b) conducted in a public-school setting with traditionally trained teachers, larger class size, and more representative socioeconomic status; and (c) students will represent the demographics of the community (Palike et al., 2014). Future single-sex classroom studies should consider similar methods while examining the influence of single-sex classrooms over the course of a full academic year.

Lack of professional training on single-sex classroom instruction was a limiting factor in this quasi-experiment. Advocates for single-sex classrooms argue that males and females have biological differences that need specialized attention. In educational settings, single-sex classrooms allow for instructors to tend to biological differences by amending their pedagogy (Sax, 2017). Teachers did not receive any type of training on teaching methodologies for single-sex classrooms in this study. Nor were the teachers assessed on their pedagogical knowledge. Thus, future research can investigate interventions to determine if single-sex classrooms are more effective if teachers receive pedagogical training on single-sex classrooms beforehand.

Agriculture classes are effective in increasing student interest in the agriculture, food, and environment career pathway; however, the combination of single-sex classrooms and the sex of the student did not have a greater influence on the interest levels. According to Lundry et al. (2015), the primary goal of SBAE is to develop the knowledge and skills necessary for employment in the agriculture industry. However, students must first have interest in the agriculture, food, and environment career pathway. The results reveal a relatively quick (over 15-weeks) increase in student interest for the students; however, the scholars are motivated to further evaluate the research model over the course of an entire academic year.

The combination of single-sex classrooms and sex of the student had a significant effect on students' interest in the education and training career field and the agricultural education career pathway. Both girl and boy treatment groups had a greater improved career interest in teaching, as opposed to their control counterparts. The researchers realized that the interest is from the minds of secondary freshman, but the significance is present. Coyle et al. (2022) found that the relationship of the teacher with their students has a significant effect on school culture and career interest, including teaching, among youth. Similarly, it is inferred that the single-sex teacher participants in this study created a relationship that influenced students' interest in pursuing a career like their teacher. Although additional research is needed to further consider this phenomenon, state departments of education, may consider this technique when exploring approaches to promoting the teaching career.

It is recommended that agricultural education researchers extend the merits of these finding through qualitative inquiry. Qualitative investigation can aid in the debate on the effectiveness single-sex classrooms could have in public schools and in agricultural education, from a sociology perspective of functionalism (Mahner & Bunge, 2001). As stated by Creswell and Creswell (2018), the research questions of quantitative investigations, such as this study, answer the questions of *if* while qualitative research answers *why* or *how*.

Longitudinal investigations into the impacts of single-sex classrooms hold promise for filling notable gaps in the current scholarly discourse. Such studies offer the opportunity to illuminate how the presence of single-sex educational settings shapes students' academic trajectories over time. Extending beyond the confines of short-term assessments, longitudinal research enables a nuanced understanding of the enduring effects of single-sex education on various educational outcomes. For instance, longitudinal studies by Franklin & Rangel (2024) and Sikora (2014) have demonstrated how attending single-sex schools can influence students' academic performance, attitudes, and career aspirations over successive years. Furthermore, these investigations underscore the need for comprehensive assessments that track students' development across key educational stages. To advance our understanding in this area, future research should prioritize longitudinal designs that span multiple years and encompass diverse student populations. Additionally, employing mixed-method approaches could provide richer insights into the complex interplay of factors influencing students' experiences and outcomes in single-sex classrooms. By adopting a longitudinal perspective and embracing methodological diversity, scholarship can offer more robust evidence to inform educational policies and practices.

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