

TECHNICAL SKILL ASSESSMENTS AS A PREDICTOR OF AGRICULTURE STUDENTS' SUCCESS AFTER HIGH SCHOOL

Michael Pantleo

University of Central Missouri

Michelle Conrad

University of Central Missouri

Kemaly Parr

Murray State University

Brian Parr

Murray State University

This study was conducted using quantitative methods to determine if a relationship exists between former Agriculture Career and Technical Education (CTE) concentrators' Technical Skills Assessment (TSA) performance and their attaining related placement after high school. The study included data from 13,581 agriculture students who graduated during the years 2015-2019. To investigate the relationship between TSA assessment performance and attaining related placement, multiple descriptive models were run and disaggregated by gender, race/ethnicity, Individuals Education Plan (IEP) status, and Socioeconomic Status (SES). The data revealed students who pass their TSA assessment are more likely to attain related placement compared to those not passing their assessment. Agriculture students' rates of passing the TSA assessment and attaining related placement were high. Additional analysis to determine the relationship between TSA assessment performance and attaining related placement involved multiple binary logistic regression models. The logistic regression models helped determine how passing the TSA assessment and student demographics interacted and influenced students attaining related placement. Statistically significant findings were determined for TSA assessment, Black students, and those not disadvantaged in the SES category. The findings from this study may add merit to the numerous secondary CTE agriculture education programs in the United States.

Keywords: Agriculture education, technical skill assessment, CTE accountability measures, industry-recognized credential



Creative Commons CC-BY-NC-ND: This article is distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>) which allows others to download your works and share them with others as long as they credit you, but they can't change them in any way or use them commercially.

Introduction

Agriculture education provides a basis for career readiness through “an integrated experience for students by providing workplace skills, leadership development, and an application of academic material” (Mouser et al., 2019, p. 15). In Missouri, the assessment of workplace skills and the application of academic material culminate in the Technical Skill Assessment (TSA) towards the end of the secondary program of study. TSAs have been one of numerous accountability measures placed on Local Education Agencies (LEAs) receiving Federal Perkins funds. Perkins V officially named the Strengthening Career and Technical Education for the 21st Century Act, supplies nearly \$1.1 billion to support Career and Technical Education (CTE) programs in the United States (PL 115-224, 2018). TSA is one system of accountability to ensure an adequate return on investment.

The CTE model as a whole has proven successful by helping students engage, attend, complete, and transition into employment or post-secondary education (Bishop & Mane, 2004; Brunner et al., 2019; Closs, 2010; Dougherty, 2016; Gottfried & Plasman, 2018; Loveless, 2011; Moss, 2015). As one of multiple CTE program areas available to students across the United States, agriculture education has situated itself to be a model for offering students a path to success. Modern agriculture programs challenge students with real-life, hands-on skills in preparation for over 300 careers (Lundry et al., 2015). Industries have a need for skilled employees and offer students pathways to earning a quality living-wage without college debt (Dougherty, 2016). Plasman’s (2019) study aligned with Dougherty and showed that students who concentrated in agriculture and natural resources were significantly more likely to see a \$1.80 per hour wage increase over their counterparts who did not pursue those fields of study.

When a student achieves a certain level of technical skill attainment by virtue of participating in an agriculture education program, it remains to be seen if they will reap any benefits. While that achievement might be as simple as an academic grade, it might also lead to opportunities that would otherwise not have existed. Staklis and Klein (2010) noted, “research, however, has yet to fully relate technical skill levels, as measured by high school graduates’ performance on broad work readiness or narrow, occupation-specific technical skill assessments, to their subsequent employment and/or postsecondary enrollment outcomes” (p. 1). The relationship between agriculture students passing their TSA and achieving success after high school is ambiguous and merits further investigation.

Related Literature

While this study focused specifically on secondary agriculture students, the broader CTE literature provided a context for how TSAs were utilized. Staklis and Klein (2010) indicated that most previous research was dedicated to the employment, earnings, and performance of a student as it relates to their assessment scores. Staklis and Klein also noted that CTE students were expected to enter the workforce after high school, and the TSA is necessary for students to demonstrate they have the knowledge and skills required. More recently, the college and career readiness movement provides the potential for college or career, as evidenced by Moss (2015) and Dougherty (2016). Both found positive results linking CTE concentrators to higher rates of enrollment in post-secondary education.

Staklis and Klein's (2010) study utilized student TSA scores and high school graduate placement status from the Pennsylvania Department of Education. Staklis and Klein were focused on determining if technical skill level or TSA assessment level could be used to predict whether or not students would enroll in post-secondary education.

Staklis and Klein (2010) identified two items of note that differed from this research. First, CTE students in Pennsylvania who were in programs with specific TSAs were given a workplace readiness assessment offered by National Occupational Competency Testing Incorporated (NOCTI). Second, Pennsylvania used four levels to categorize TSA passing, i.e., Advanced, Competent, Basic, and Below Basic, instead of a pass or fail system. Staklis and Klein determined that student TSA skill levels were positively associated with enrollment in post-secondary education. Future research was recommended to offer additional insights into the relationship between TSA and post-secondary enrollment or workforce outcomes (Staklis & Klein, 2010).

Plesnarski (2018) also conducted a study with student data from Pennsylvania and had similar findings to those of Staklis and Klein (2010). Plesnarski's findings revealed that end of program assessments were a statistically significant predictor of positive post-high school placement. Plesnarski added a suggestion to replicate the study using additional years of data including all CTE program areas, which could have different results and might offer a more comprehensive outcome. Additionally, Plesnarski suggested disaggregating the data by student demographic and type of positive placement to determine trends (Plesnarski, 2018).

Another study conducted by Ryan (2019), utilized student data from a Missouri shared-time area career center in which Ryan served as the building administrator. The findings were positive, as Ryan noted a positive moderate correlation between students who passed their TSA and entered a field related to their CTE program area (Ryan, 2019).

Narrowing the scope of the related research to agriculture education led to the discovery of a study conducted by Nolin and Parr (2013). Language, math, and social studies scores on the Alabama high school exam were used to determine if a relationship existed. The results from the study revealed a significant relationship between the language and math scores but not social studies. Specifically, the findings revealed that

the more agriculture classes a student took, the odds of them scoring higher on the language and math sections of the exam increased (Nolin & Parr, 2013).

The Staklis and Klein (2010) study previously mentioned also specifically included the pass rates of agriculture students. The five CTE program areas included in the study were agriculture, business/marketing, health occupations, occupational home economics, and trade and industrial education. Staklis and Klein's study did not present data for specific CTE program areas in the logistic regression models but did mention that scoring at the basic and advanced levels was a statistically significant predictor for agriculture students entering post-secondary education compared to those scoring at the below basic level (Staklis & Klein, 2010). Staklis and Klein emphasized the positive relationship between agriculture students scoring at the advance and basic levels and post-secondary enrollment was an exception to the overall findings in the study. Of the five CTE program areas included in the study, agriculture and occupational home economics were the only two program areas where this positive relationship was found (Staklis & Klein, 2010).

There are a small number of previous studies focused on the relationship between TSA and post-high school success (Plesnarski, 2018; Staklis & Klein, 2010). However, there have been no related studies that included the student demographic variables gender, race/ethnicity, IEP status, and socioeconomic status (SES). The interaction of these variables and how they affect students' post-high school success can be important to stakeholders in all education settings.

In Missouri, the approved TSAs for agriculture programs are the Missouri Agriculture Skill and Knowledge assessments (MOASK). The MOASK TSAs are administered through state career development events (CDE). The MOASK TSAs offered through the CDEs are coordinated and completed through cooperative agreements involving Missouri Department of Elementary and Secondary Education (MODESE) staff, agriculture educators, and Missouri Farm Bureau staff (MODESE, 2021). In the context of this study, the MOASK assessments were one and the same as TSAs.

To earn a MOASK TSA credential, students are required to pass both a written and a performance assessment. Students are eligible to earn technical skills assessment credentials in 15 areas: agriculture mechanics, agronomy, dairy cattle evaluation, dairy foods evaluation, entomology, farm business management, floriculture, forestry, grasslands, horse evaluation, livestock evaluation, meats evaluation, nursery/landscaping, poultry evaluation, and soils evaluation. Special accommodations are available and allowed for students participating in MOASK assessments. Teachers can request accommodations and modifications from the state CDE superintendent and the MODESE staff based on the student's IEP, food allergies, a physical disability or injury, etc. (MODESE, 2021).

Theoretical Framework

The theoretical framework guiding this study, similar to that of Plesnarski (2018), was based on the social cognitive career theory (SCCT). SCCT was derived from Bandura's general social cognitive theory. SCCT offers a framework for career

development by connecting the interrelationships between educational and vocational interests, career-related choices, and performance (Brown, 1999). SCCT considers social cognitive variables (e.g., self-efficacy) and their relationship with other variables in the individual's socio-contextual environment, such as gender, race/culture, family, community, and political components (Brown, 1999).

Educational and vocational interests explained how self-efficacy, outcome expectations, and goals were key to career choice and performance (Lent et al., 1994). Students' interests develop and change multiple times, even into the later adolescent years (Lent et al., 1994). While most interests remain steady, an impactful new learning experience could still lead to changes in interests after the adolescent years (Lent et al., 1994). CTE, specifically agriculture education, has the potential to be this type of learning experience. As students move through agricultural coursework and experience success, self-efficacy as well as outcome expectations increase. These increases can change the direction of a student's career path.

Career-related choices in the SCCT build on the interest component of the model. Students' career choices are influenced more by self-efficacy beliefs, outcome expectations, or environmental factors than by interests (Lent et al., 1994). Previous studies have reported how self-efficacy relates to the decisions of high school students in pursuing careers in agriculture (Marx et al., 2014; Priest, 2008). In addition, personal traits such as gender, race, disability, personality, predispositions, and background combine to influence learning, which influences self-efficacy and outcome expectations (Lent et al., 1994). All of these factors combine to influence performance attainment (Lent et al., 1994).

Performance attainment was the most relevant and beneficial SCCT component to this study; in Missouri, when students take three courses and become agriculture concentrators, they have shown a propensity for interest in a specific career path. Their self-efficacy and determination levels would have increased, translating to students setting higher-level performance goals, which, in turn, lead to increased levels of performance or attainment (Lent et al., 1994). This was particularly important in this study when considering if passing the TSA resulted in positive post-high school success.

Purpose of the Study. The purpose of this study was to determine if agriculture students who passed their TSA were more likely to be placed in related employment, related post-secondary education, or the military when compared to those who did not pass their assessments. The research questions that guided this study included:

1. Is there a relationship between Missouri agriculture students who pass their TSA assessment and attaining employment, entering post-secondary education, or entering the military in a field related to their agriculture program?
2. What role does the agriculture students' demographics of gender, race/ethnicity, having or not having an individualized education plan (IEP), and being or not being disadvantaged play in influencing TSA performance and post-high school related placement?

Methods

This research used a quantitative research design and method of analysis to determine if a relationship existed between agriculture completers' TSA performance and post-high school related placement. For this study, an agriculture completer was defined as an agriculture concentrator who graduated from high school or received a General Education Diploma (GED) (MODESE, 2019). The study was conducted using data from the years 2015-2019. Only data from agriculture students who met the Perkins concentrator definition were included in the study. In 2015-2019, a Missouri Perkins concentrator was defined as students earning three or more CTE credits in a program study (MODESE, 2019). The definition changed to two credits in 2020 as a result of the Strengthening Career and Technical Education for the 21st Century Act (PL 115-224, 2018).

Quantitative statistical methods were used to analyze the data and interpret the results. Quantitative research uses empirical data to determine cause and effect and make predictions (Merriam & Tisdell, 2016). Since the independent variable related placement was not manipulated and it occurred in the past an ex post facto, also known as a casual comparative design, was utilized (Ravid, 2020).

Descriptive statistics were presented to describe the makeup of the study's population (N), consisting of Missouri agriculture students meeting the CTE concentrator definition. These data were analyzed by total participants (N) for five years and by participant categories (n) gender, race/ethnicity, IEP status, and SES. In Missouri, SES is determined by those who qualify for free and/or reduced school lunches (MODESE, 2021).

A binary logistic regression analysis was used to determine if a relationship existed between agriculture concentrators' TSA performance and post-high school related placement. According to Kleinbaum et al. (2008), "logistic regression analysis is the most popular regression technique available for modeling dichotomous dependent variables" (p. 604). Kleinbaum et al. also stated, "logistic regression helps determine how one or more independent variables are related to the probability of the occurrence of one or two possible outcomes" (p. 12). Specific to this study, the logistic regression helped determine the relationship between the independent variables of TSA performance, gender, race/ethnicity, IEP status, and SES and the dependent variable-related placement.

To address research questions one and two, TSA assessment data and related placement results were analyzed using the binary logistic regression function within SPSS (See Tables 2 and 3). The logistic regression models were used to determine the relationship between the dichotomous dependent outcome variable related placement and the dichotomous independent predictor variable TSA performance, which was pass/fail on the assessment. To address research question two, gender, race/ethnicity, IEP status, and SES were added to the models. Odds ratios (OR) and the odds percentages of attaining related placement for each model were also determined using SPSS's logistic regression functionality. Odds ratios were considered the odds of a participant attaining related placement when controlling for those who passed the TSA assessment and the other independent variables in each model. The odds ratios' percentage increases or decreases were presented to help clarify the results. To determine if the independent

variable in the logistic regression model was significant, the Wald test was utilized. For this study, Wald values less than $p < .05$ were considered statistically significant.

Participants. It was determined that the data required for this study were available and could be sent with no identifiable information from the MODESE College and Career Readiness Data supervisor. An Excel spreadsheet, pre-populated with headings identical to the MODESE data file-set codes, was developed to meet the data supervisor's request. Data requested were downloaded into this spreadsheet for analysis (MODESE, 2019). After obtaining IRB approval, the data collection spreadsheet was sent to the MODESE data supervisor. The requested data were returned within one week of the request.

To be included as a participant in this study, two criteria had to be met. First, the students had to be Missouri secondary agriculture completers from the years 2015-2019. Second, the students' school districts of record had to have submitted the data required for this study to MODESE. For clarification, only students with TSA and placement status data in the MODESE database from the five years were participants in this study.

Table 1 presents a 5-year description of all the agriculture participants by student demographics, which were the independent categorical variables used in this study. The trends over the 5 years showed males as the largest participant gender, $n = 7,460$ (55%) compared to females $n = 6,121$ (45%). Within race/ethnicity, the largest participant group was White, $n = 13,035$ (96%). As far as IEP status, participants without an IEP, $n = 12,680$ (93%) were a much larger group than those with an IEP. Finally, students not disadvantaged were a larger group of participants, $n = 9,636$ (71%).

Table 1

Description of Participants				
Demographic	Category	n	%	Total
Gender	Males	7,460	54.9	N = 13,581
	Females	6,121	45.1	
Race/Ethnicity	Asian	26	0.2	
	Black	178	1.3	
	Hispanic	178	1.3	
	Indian	70	0.5	
	Mixed Races	86	0.6	
	Pacific Islander	8	0.1	
	White	13,035	96	
IEP Status	No IEP	12,680	93.4	
	Has IEP	901	6.6	
SES Status	Not Disadvantaged	9,636	71	
	Disadvantaged	3,945	29	

Variables in the Study. The dependent variable in this study consisted of one dichotomous outcome variable, related placement. The independent variables included

one dichotomous predictor variable, TSA assessment status, and four categorical independent variables: gender, race/ethnicity, IEP status, and SES. The demographic coding was as follows: gender: females = 0 and males = 1; race/ethnicity: Asian = 0, Black = 1, Hispanic = 2, Native American (Indian) = 3, Mixed Races = 4, Pacific Islander (PI) = 5, and White = 6; IEP status: has IEP = 0 and no IEP = 1; SES status: disadvantaged = 0 and not disadvantaged = 1. The White categorical variable was used as the race/ethnicity reference to which the others were compared. The TSA assessment status was coded as follows: fail = 0 and pass = 1; placement status coding: not placed in a related field = 0; placed in a related field = 1. Data cleaning was completed on the research instrument Excel spreadsheet before uploading the data into SPSS for statistical computation.

Findings

TSA Assessment and Related Placement Performance of Agriculture Students. To provide additional clarification before specifically addressing the research questions, TSA assessment and related placement results were analyzed using the crosstabs function within SPSS. Table 2 presents all agriculture students' TSA performance (pass or fail) and placement outcome (related or not related). When viewing all students' results for TSA performance, those passing their TSA, $n = 11,298$, was over 83% of the overall student total. Those who failed their TSA, $n = 2,278$, were almost 17% of the overall student total. This study's focus group, those students passing their TSA and attaining related placement, $n = 8,677$, was almost 77% of those passing the assessment. Students who failed their TSA but still attained related placement, $n = 1,583$, was almost 70% of those who failed the assessment.

Table 2

Results for TSA and Placement

			Placement		Total
			Not Related Placement	Related Placement	
<i>N</i> = 13,581					
TSA	Failed Test	Count	695	1,583	2,278
		% within TSA	30.5%	69.5%	100%
		% within Placement	20.9%	15.4%	16.8%
		% of Total	5.1%	11.7%	16.8%
Passed Test	Count	Count	2,626	8,677	11,303
		% within TSA	23.2%	76.8%	100.0%
		% within Placement	79.1%	84.6%	83.2%

		Placement			
		% of Total	19.3%	63.9%	83.2%
Total	Count	3,321	10,260	13,581	
	% within TSA	24.5%	75.5%	100.0%	
	% within Placement	100.0%	100%	100%	
	Placement				
	% of Total	24.5%	75.5%	100%	

Relationship between TSA Assessment Performance and Attaining Related Placement. Table 3 presents the logistic regression output with related placement as the dependent outcome variable and TSA assessment, pass/fail, as the independent predictor variable. This model included all participants, $N = 13,581$. The logistic regression analysis to determine if there was a relationship between TSA performance (TSA) and related placement was conducted. The predictor variable, TSA, in the logistic regression analysis was found to contribute to the model. The unstandardized Beta weight for the constant was: $B = (.975)$, $SE = .047$, $Wald = 431.131$, $p < .001$. The unstandardized Beta weight for the predictor variable TSA was: $B = (.372)$, $SE = .051$, $Wald = 53.931$, $p < .001$. The estimated OR favored an increase of over 45% [$Exp(B) = 1.451$, 95% CI (1.314, 1.602)] for attaining related placement when the TSA assessment was passed compared to it not being passed. Agriculture students who passed the TSA were 1.45 times more likely to attain related placement than those failing the assessment.

Table 3

Logistic Regression Results

Program	Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)		OR % Incr. or Decr.
								LL	UL	
Ag $N = 13,581$	Constant	.975	.047	431.131	1	.000*	2.652	-	-	-
	TSA	.372	.051	53.931	1	.000*	1.451	1.314	1.602	45%

Note. TSA represents passed assessment; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit; OR = Odds Ratio; $Exp(B) = OR$; Incr. = Increase; Decr. = Decrease; $N = 13,581$
* $p < .001$.

Relationship between TSA Assessment Performance and Attaining Related Placement when Accounting for Student Demographics. The analysis of the second research question of this study provided insight into the effects and interaction of all the independent variables on the dependent outcome variable, attaining related placement.

This analysis contained three logistic regression models. Model A included gender and race/ethnicity. Model B added IEP status and SES to the variables in Model A. Model C added TSA assessment to the variables included in Models A and B. The models included all of the agriculture students in the study.

Table 4 presents the logistic regression results in three models or steps. Model A, containing gender and the race/ethnicity categories, revealed significant findings for male students in the gender category and Black, Hispanic, and Mixed students in the race/ethnicity category. Model A illustrates a statistically significant difference in the odds of males and females attaining related placement, $p < .05$. When compared to females, males were almost 1.8 times more likely to attain related placement after graduating from high school when controlling for race/ethnicity. In other words, male agriculture students' odds of attaining related placement were almost 80% higher than female agriculture students. Within the race/ethnicity category, there were three groups of students who had less than desirable results when compared to White agriculture students. Black, Hispanic, and Mixed-Race agriculture students' odds of attaining related placement decreased by factors of .62, .29, and .44 respectively compared to White agriculture students when controlling for gender.

Model B added the categorical independent variables IEP status and SES to determine the odds of agriculture students in these two categories attaining related placement. Agriculture students with IEPs, when compared to those without IEPs, had findings that were not significant $p > .05$. Agriculture students who were not disadvantaged had higher odds of attaining related placement compared to those disadvantaged. The odds ratio of 1.22 signified a 22% increase in the odds of non-disadvantaged students attaining related placement compared to those disadvantaged. By adding IEP status and SES in Model B, the odds of males attaining related placement slightly increased from 1.79 to 1.80 when controlling for race/ethnicity, IEP status, and SES.

In Model C, the independent predictor variable TSA was added. TSA represents those agriculture students who passed the TSA assessment compared to those who failed the assessment. When controlling for gender, race/ethnicity, IEP status, and SES, the odds of agriculture students who passed the TSA assessment and attained related placement increased from 1.45 times to 1.5 times higher than the odds of those who failed the assessment as found in research question one. Essentially, agriculture students who passed the TSA assessment had 50% higher odds of attaining related placement than those who failed when the demographic variables were controlled.

With TSA added in Model C, gender remained statistically significant, $p < .05$. The odds ratio for gender increased from 1.79 in Model A to 1.84 in Model C when controlling for race/ethnicity, IEP status, SES, and TSA. For race/ethnicity, Black and Mixed-Race agriculture students remained statistically significant, $p < .05$, when controlling for gender, IEP status, SES, and TSA. The odds of attaining related placement still signified a decrease in the odds when compared to White students, but the decrease slightly lessened from .373 to .419 for Black students and from .566 to .601 for Mixed-Race students. IEP status continued as not statistically significant, $p > .05$. SES remained statistically significant, $p < .05$, but decreased in Model C. When controlling for gender,

race/ethnicity, IEP status, and TSA, the odds of disadvantaged students attaining related placement decreased from 1.22 (22%) in Model B to 1.19 (19%) in Model C.

Table 4*Logistic Regression Models*

Variable	Model A			Model B			Model C		
	Odds Ratio	SE	95% CI	Odds Ratio	SE	95% CI	Odds Ratio	SE	95% CI
Gender (Male = 1)	1.794*	.040	1.66-1.94	1.80*	.041	1.67-1.95	1.84*	.041	1.70-1.99
Race/Ethic. ¹									
Asian	.802	.446	.334-1.93	.808	.446	.377-1.94	.783	.446	.326-1.88
Black	.373*	.153	.277-.504	.410*	.154	.303-.554	.419*	.155	.309-.568
Hispanic	.706*	.165	.511-.975	.753	.166	.544-1.04	.763	.166	.551-1.06
Indian	.864	.267	.512-1.46	.882	.268	.522-1.49	.906	.268	.535-1.53
Mixed	.566*	.288	.363-.885	.602*	.229	.385-.942	.601*	.229	.383-.941
PI	1.813	1.07	.222-14.8	2.03	.107	.247-16.6	2.06	1.07	.252-16.9
IEP (No IEP = 1)				1.08	.082	.917-1.26	.994	.083	.845-1.17
SES (Not Disadvantage = 1)				1.22*	.044	1.11-1.33	1.19*	.044	1.09-1.30
TSA (Passed TSA)							1.50*	.052	1.36-1.66
Likelihood ratio Chi-squared			270.862			291.534			350.554
			N = 13,581			N = 13,581			N = 13,581

*Significant at the $p < .05$ level. ¹ Omitted category: White. CI = Confidence Interval.

Conclusions

In aggregate, the results revealed for research question one showed a majority of the agriculture students passed their TSA assessment and attained related placement. Missouri's agriculture education system is well organized, and most programs' curricula align with the TSA assessments. These aforementioned factors more than likely contributed to the high TSA pass rates. One interesting finding revealed that 70% of those who failed their TSA assessment still attained related placement. One factor that may have caused these high placement rates is Missouri's vast rural landscape. Numerous

farming and agribusiness employment opportunities may be beneficial to those pursuing careers in agriculture.

The logistic regression findings were extremely positive for agriculture education in Missouri. The results showing that agriculture students who passed the TSA are 45% more likely to attain related placement were significant at the $p < .05$ level. These results even increased to 50% more likely when the demographic variables of gender, race/ethnicity, IEP, and disadvantage were controlled. These positive results were likely related to the high TSA pass rates combined with the high percentage of students attaining related placement. These two factors influenced the high odds ratios in the logistic regression model.

The three logistic regression models used to answer research question two included the student demographics also referred to as the independent categorical variables. The results from the three models demonstrated how the students' demographics interacted and affected the odds ratios of attaining related placement. The notable statistically significant finding within student demographics was the odds ratio of males attaining related placement compared to females. The 1.79 odds ratio in Model A and its increase to 1.84 in Model C indicated males in agriculture are more likely to attain related placement after high school than females when controlling for the other variables.

Black agriculture students and those of Mixed-Race had concerning results, even though there was some lessening of the odds ratio from Model A to Model C. The low TSA pass rates and the low attainment of related placement were probably driving these results. Additionally, disadvantaged students' results were concerning. The SES results from Model 3 revealed an odds ratio of 1.19, signifying 19% higher odds of attaining related placement for those not disadvantaged when compared to those disadvantaged. Another positive finding for agriculture was that throughout all three models, IEP status is not significant. This result would indicate that there was not a significant difference in overall performance between students with IEPs and those without IEPs.

Discussion, Implications, and Recommendations

Only a small number of studies exist with a focus on the relationship between CTE end of course assessments and placement after high school. This study was conducted using five years of Missouri agriculture education completer data and could potentially add to the small body of research studying agriculture education and CTE. Even though this study had positive findings similar to much of the previous research covering all CTE program areas (Plesnarski 2018; Ryan 2019; Staklis & Klein, 2010), the size, scope, and additional demographics analyzed offer significantly more insight into the relationship between agriculture education graduates' TSA performance and attaining related placement.

The findings of this study do present opportunities to celebrate Missouri's agriculture education system. There is a high level of success in helping students pass the TSA assessments, and passing the TSA is a positive predictor of attaining related placement after high school with increased odds by a factor of 1.45. This confirms the results of Plesnarski (2018), Ryan (2019), and Staklis and Klein (2010).

Were these positive results related to aligned curricula, effective instructional practices, or possibly the amount of funding dedicated to CTE in Missouri? All or some of these factors might play a role in these results. These factors could also be the basis of future research projects to explore how these positive results are being achieved. And while the TSA is a positive predictor of attaining post-secondary positive placement, another future study could focus on students' completion of two or four-year agriculture-related degrees.

The non-significant findings related to IEP status are another unexpected result of this study. Findings of this study revealed that equity is being achieved for students with an IEP compared to their non-IEP peers. While this might be a result of IEP students having appropriate accommodations and modifications throughout the curriculum or in the MOASK exam itself, it is unclear how IEP students are achieving related placement at the same rates as their non-IEP peers. These are issues that should be explored further in future research. There was concern, however, when IEP status was coupled with disadvantaged status. Students with IEPs and disadvantaged status had .03 decreased odds of attaining related placement. Even though this was not a large decrease, it still raised a concern that warrants further investigation. A future study analyzing the interaction effects of IEP and SES on related placement could be valuable.

Unfortunately, no previous related research specifically included agriculture students and analyzed TSA and related placement relationships by gender, race/ethnicity, IEP status, and SES status. Staklis and Klein's (2010) findings did not support this study's results for the attainment of related placement by gender. The odds of females entering post-secondary education were higher than those of males (Staklis & Klein, 2010). This study did not compare gender performance for TSA, but Staklis and Klein's results indicated females performed better on their TSAs. Mouser et al. (2019) and Dougherty (2016) analyzed gender but not by comparing each gender's performance against the other. Rather, Dougherty compared female and male CTE concentrators to non-CTE concentrators, and Mouser compared female and male agriculture students from gold and silver emblem FFA programs to female and male non-agriculture students.

There were some concerns raised in the findings of this study related to gender and race/ethnicity. Females were 1.74 to 1.84 times less likely to find related placement than their male counterparts. Black and Mixed-Race students' odds of attaining related placement decreased by factors of .373-.419 and .566-.601 respectively when compared to their White classmates. The race/ethnicity results in this study, were not supported by Staklis and Klein (2010). Additionally, the 1.22 to 1.19 odds of attaining related placement for non-disadvantaged students compared to those disadvantaged were somewhat concerning.

While gender equity has been at the forefront of career and technical education for many years, the results of this study clearly demonstrated the continued importance of focusing on this gender gap. Disadvantaged students can have multiple challenges hindering their performance, but typically CTE increases opportunities for success. CTE's underlying positive effects may be present in this study as the significant odds ratio differences were less drastic than those between gender and race/ethnicity. Missouri's race/ethnicity makeup is 82% White, followed by Black at almost 11%.

Inequalities seen in this study brought to light the inequalities that continue to be seen in education systems.

Since this study only included student data from Missouri, a judgment regarding other states cannot be made. Since this study utilized five years of data, including over 13,500 students, the concerns raised about these groups of students in Missouri need further attention to determine the root causes of the underperformance. Attention also needs to be paid to whether or not gender or cultural concerns have an impact on students regarding agriculture as a career pursuit. Future research to examine these differences is needed to gain a greater understanding of these findings. A parallel study in a state where the population is more diverse may offer additional insights to address the educational needs of underrepresented populations as well.

Summary

The relationship between TSA assessments and post-graduation related placement for agriculture education students in Missouri is strong. Additional research is still needed, however, on varying populations of students to ensure career readiness for all agriculture students in Missouri. This research does demonstrate that quality, industry-aligned, and program specific end of course assessments, such as TSAs in Missouri, could be one of the modalities moving agriculture education to the forefront as a proven education model for student success.

References

- Bishop, J., & Mane, F. (2004). The impacts of career-technical education on high school labor market success. *Economics of Education Review*, 23(4), 381–402. <https://doi.org/10.1016/j.econedurev.2004.04.001>
- Brown, B. L. (1999). *Self-efficacy beliefs and career development*. ERIC Digest No. 205. <https://eric.ed.gov/?id=ED429187>
- Brunner, E., Dougherty, S., & Ross, S. (2019). The effects of career and technical education: Evidence from the Connecticut technical high school system. (EdWorkingPaper: 19-112).
- Closs, R. (2010). The association between career and technical education and implications for programming and attendance for secondary school students (Publication No. 3427655) [Doctoral dissertation, Walden University]. ProQuest Dissertations and Theses Global.
- Dougherty, S. M. (2016). Career and technical education in high school: Does it improve student outcomes? *Thomas B. Fordham Institute*. <https://rb.gy/cbaioq>
- Gottfried, M. A., & Plasman, J. S. (2018). Linking the timing of career and technical education coursetaking with high school dropout and college-going behavior. *American Educational Research Journal*, 55(2), 325–361. <http://doi.org/ggf5wv>
- Kleinbaum, D. G., Kupper, L. L., Nizam, A., & Muller, K.E., (2008). *Applied regression analysis and other multivariable methods* (4th ed.). Brooks/Cole Cengage Learning.
- Lent, R. W., Brown, S., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, 45(1), 79–122.

- Loveless, M. (2011). *Career and technical education (CTE) graduation rates in Tennessee: A comparative study* (Publication No. 3476279) [Doctoral dissertation, East Tennessee State University]. ProQuest Dissertations and Theses Global.
- Lundry, J., Ramsey, J. W., Edwards, M. C., & Robinson, J. S. (2015). Benefits of career development events as perceived by school-based, agricultural education teachers. *Journal of Agricultural Education, 56*(1), 43-57. DOI: 10.5032/jae.2015.01043
- Marx, A. A., Simonsen, J. C., & Kitchel, T. (2014). Secondary agricultural education program and human influences on career decision self-efficacy. *Journal of Agricultural Education, 55*(2), 214-229.
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass Publishers.
- Missouri Department of Elementary and Secondary Education (MODESE) (2019). *MSIP 5 Comprehensive Guide*. <https://dese.mo.gov/sites/MSIP5>
- Missouri Department of Elementary and Secondary Education (MODESE) (2019). Carl D. Perkins Career and Technical Education Act of 2006 Instructions for Perkins IV Secondary Accountability Reporting, 218-219. <https://dese.mo.gov/sites/default/files/perkins-iv.pdf>
- Missouri Department of Elementary and Secondary Education (MODESE). (2021). *CDE guidelines revised*. <https://dese.mo.gov/media/pdf/cde-guidelines-revised-12-15-21>
- Missouri Department of Elementary and Secondary Education (MODESE). (2021). *Core Data and MOSIS Manual*. <https://dese.mo.gov/media/pdf/core-data-and-mosis-manual>
- Moss, R. A. (2015). *The impact of secondary career and technical education on postsecondary career and educational placement* (Publication No. 10125130) [Doctoral dissertation, Lindenwood University]. ProQuest Dissertations and Theses Global.
- Mouser, D. M., Sheng, A., & Thoron, A. C. (2019). Are agriculture students more career ready? A comparative analysis of Illinois juniors. *Journal of Agricultural Education, 60*(2), 15-27. <https://doi.org/10.5032/jae.2019/02015>
- 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 Agriculture Education, 54*(3), 41-53. DOI: 10.5032/jae.2013.03041
- Plasman, J. S. (2019). Linking occupational concentration to hourly wages for non-college going individuals. *The Journal of Career and Technical Education, 34*(1), 29-51. DOI: <http://doi.org/10.21061/jcte.v34i1.a2>
- Plesnarski, C. E. (2018). Measures of technical skill attainment and their predictive value on positive post-program placement of Pennsylvania secondary career and technical students (Publication No. 10841257). [Doctoral dissertation, Delaware Valley University]. ProQuest Dissertations and Theses Global.
- Priest, K. L. (2008). *The influence of learning activities on the career decision self-efficacy of high school seniors in agricultural education* [Master's thesis, University of Georgia]. https://getd.libs.uga.edu/pdfs/priest_kerry_1_200808_mal.pdf
- Ravid, R. (2020). *Practical statistics for educators* (6th ed.). Rowman & Littlefield.
- Ryan, M. D. (2019). Work readiness of career and technical education students: The relationship between technical skill attainment scores and post-graduation follow up placement rates. [Unpublished education specialist thesis]. University of Central Missouri.
- Staklis, S., & Klein, S. (2010). Technical skill attainment and post-program outcomes: An analysis of Pennsylvania secondary career and technical education graduates. National Research Center for Career and Technical Education. <http://eric.ed.gov/?id=ED521333>

Strengthening Career and Technical Education for the 21st Century Act, Pub. L. No. 115-224,
132 U.S. Statutes 1563 (2018).