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An Examination of Factors that Interact to Shape Academic Outcomes in an Animal Nutrition Course

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Abstract

Academic success in rigorous agricultural science courses like animal nutrition may be influenced by various student factors including demographics, preparedness behaviors, prior academic achievement, and proximity to agriculture. This study examined 1,097 students across four semesters of an animal nutrition course at a large land-grant university to identify predictors of academic performance. Using descriptive statistics and multiple linear regression analyses, our study found that prior academic success was the strongest predictor of student performance. Preparedness behaviors and certain demographic variables also demonstrated statistically significant relationships. However, agricultural proximity was the least predictive factor. Our findings highlight the importance of academic preparedness over background exposure and offer insights into improving student support strategies in agricultural education.

Introduction

Students in undergraduate animal science programs are often required to take rigorous, content-heavy courses like animal nutrition. These courses are foundational to their education, yet instructors frequently notice substantial differences in how prepared students are and how well they perform. This raises important questions about what contributes to success in these challenging learning environments. If we can better understand the factors that influence student performance, we can design more effective curricula, improve advising practices, and offer stronger support systems in agricultural colleges. Our study took a close look at four potential predictors of student success in an undergraduate animal nutrition course: demographics, academic history, agricultural proximity, and self-reported preparedness behaviors. Student outcomes in agricultural science courses are shaped by a blend of academic ability, behavior, and prior experience, and the existing research provides useful insights into how these elements may interact.

Several studies have looked at how demographic traits like sex, age, and ethnicity influence academic performance, though the findings are often mixed. For instance, Zoglmann et al. (2004) found

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that male students performed slightly better and expressed greater confidence in an introductory animal science course, even though both sexes showed similar learning gains. On the flip side, Soberon et al. (2012) reported stronger academic outcomes for female students in an animal nutrition course. Other researchers, like Peffer (2011) and Garg (2018), found that sex did not make much of a difference at all. When it comes to ethnicity, Liang et al. (2018) found no significant GPA differences, suggesting that ethnicity alone may not have a direct effect on academic success. In short, while demographics might play a role, the evidence is not consistent.

Agricultural background is often assumed to give students a leg up in animal science classes, especially if they grew up in rural areas or were involved in groups like FFA or 4-H. However, reality is a bit more complicated. Boerngen and Rickard (2020) found that even though many students claimed an agricultural background, only about half had direct livestock experience. Dunstan et al. (2021) stressed the need to clearly define "agricultural proximity" using tools like the Rural-Urban Continuum Codes. While some studies suggest that students with agricultural backgrounds feel more confident or familiar with course content (Boerngen & Rickard, 2020; Zoglmann et al., 2004), others found little or no link to actual academic performance. Bundy et al. (2019), for example, found no significant difference in test scores based on prior animal experience, and Zoglmann et al. (2004) found no performance boost from FFA or 4-H participation. That said, Mousel et al. (2006) did observe better outcomes for students with hands-on agricultural field experience in a forage management course, suggesting that the benefits of prior exposure may depend on the content of the course.

One factor that consistently predicts success is academic history. Prior academic performance, such as GPA or grades in prerequisite courses, tends to be a strong indicator of how well students will perform. Soberon et al. (2012) found that grades in chemistry and SAT scores were the best predictors of success in an animal nutrition course. Similarly, studies conducted by Vitale et al. (2010) and Burk et al. (2013) found that GPA and past coursework were key predictors of performance in advanced agricultural economics classes. These results mirror findings in broader education research: prior academic achievement statistically exceeds background experience.

In addition to academic ability, student behaviors also play a role. Behavioral factors like attendance, completing assignments, and preparing for exams have a clear impact. For instance, Fidanza (2006) showed that students who attended more than half of the lectures in a plant science course scored higher and felt more satisfied with the class. Research across many disciplines confirms that consistent attendance helps students engage more deeply and retain information (McMillan et al., 2009; Romer, 1993). While regular attendance provides the consistency needed to achieve academic success, self-regulated learning—like time management and goal-setting—provides the discipline needed to improve outcomes (Kitsantas & Zimmerman, 2008). Taken together, these studies show that while demographic traits and agricultural background can shape a student's confidence or familiarity with the subject, academic preparedness and proactive learning behaviors most reliably predict success in animal science courses. For educators, this could mean focusing on helping students build strong study habits, supporting them in prerequisite coursework, and providing clear guidance on how to engage effectively with the course material. Trautwein and Köller (2003) found that instructor support designed for student success—like structured homework and timely feedback—are especially helpful in classes that require higher-order thinking, like animal nutrition.

Study Components and Framework

Tinto's Model of Student Departure (Tinto, 1975) is a foundational theory that provided valuable insight while conducting our study. Tinto's theory has long been recognized as a cornerstone in educational research for understanding why students leave or stay in college (Karp et al., 2010). His model helped shape our thinking about how both academic and social factors play a role in student retention (Tinto, 1975).

While Tinto expanded his model in 1993 (Tinto, 1993), one of the key ideas in Tinto's work is that students are more likely to succeed when they feel a sense of connection—both academically and socially—within their university community (Christie & Dinham, 1990). On the flip side, students who feel isolated, underprepared, or unsupported are at a higher risk of dropping out (Karp et al., 2010). Simply put, when students feel like they belong and are supported in their learning environment, they are more likely to stick with their studies (Wang et al., 2019).

This idea is particularly relevant for students with agricultural backgrounds. Those who come into agriculture courses with experience in 4-H, FFA, or hands-on farm work often share a common culture and knowledge base with their peers and instructors. That shared experience can help them build stronger relationships and feel more at home in agriculture programs (Boerngen & Rickard, 2020). That sense of belonging contributes to both social and academic integration, potentially improving their success and persistence in these courses (Boerngen & Rickard, 2020).

Tinto's theory has shaped many institutional policies and support strategies aimed at boosting student retention (Christie & Dinham, 1990). He recognized that students do not come into college as blank slates; students bring with them their own goals, emotions, and academic experiences, all of which influence how they perform (do Carmo Nicoletti, 2019). Behaviors like attending class, participating in discussions, and coming to class prepared are central to Tinto's concept of academic integration. For example, when students consistently show up to class, they are not just learning course content—they are also building a connection to the academic community (Christie & Dinham, 1990). According to the model, students who actively engage in their coursework through activities such as assignment completion and test preparation are more likely to continue in their studies (Christie & Dinham, 1990). This aligns well with the research of Kitsantas and Zimmerman (2008), who emphasize the importance of self-regulated learning. Students who set goals, manage their time, and keep track of their progress are more engaged and better equipped to handle academic challenges. These behaviors not only contribute to success in individual courses like animal nutrition but also help students stay motivated and committed to their larger educational journey (Kitsantas & Zimmerman, 2008).

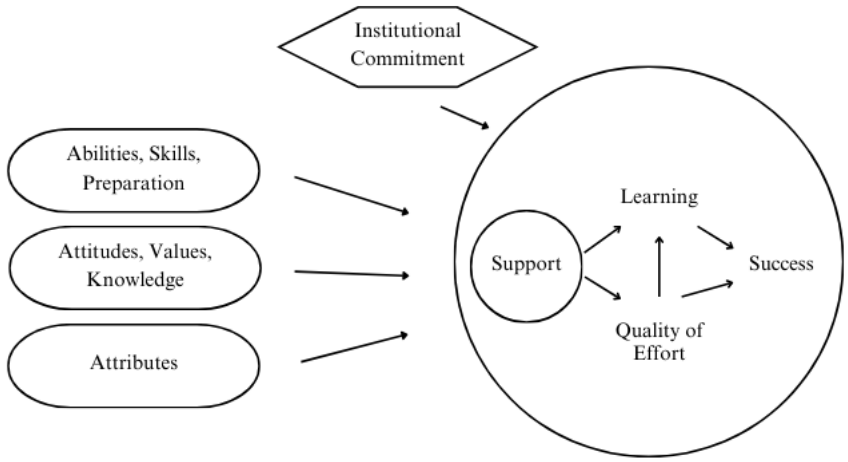
When students start an animal nutrition course, they each bring a unique mix of characteristics, experiences, and abilities to the classroom. These include personal factors like sex, age, and ethnicity, as well as their academic backgrounds and any prior exposure they've had to agriculture or biological sciences. But it's not just what they know—it's also how they approach the course. Their goals, motivations, and willingness to engage with the material all play a role in how well they perform (Tinto & Pusser, 2006). Further, many students are managing responsibilities outside of school, such as jobs, family duties, or involvement in their communities. These external pressures can have a real impact on how much time and energy they are able to dedicate to their coursework (do Carmo Nicoletti, 2019).

The institution itself also plays a big part. Factors like the college's size, structure, and location, as well as the resources it provides, such as instructional materials, curriculum quality, and faculty expertise, all shape the student experience (Tinto & Pusser, 2006). While many of these characteristics, both student and institutional, stay fairly constant during the semester, other aspects can be adjusted to better support student success (Berger & Braxton, 1998). For example, institutional commitment is a key influence that exists outside of student behaviors, and it encompasses the broader culture of support a school provides. Some of the most impactful factors are dynamic factors that can change during the course. These include the institution's level of commitment to supporting students in their learning, the expectations set by instructors, and the availability of helpful academic resources like tutoring, timely feedback, and meaningful lab experiences (Tinto & Pusser, 2006). Students benefit most when they have chances to truly interact with the course content through hands-on projects, group discussions, and real-world applications. These kinds of experiences help bring complex topics to life and make them more understandable (Berger & Braxton, 1998).

Tinto's Model of Student Departure emphasizes that it's not just about the student—it's also about the environment in which they learn. When schools and instructors commit to high-quality teaching, set clear and high expectations, and actively support student engagement, they create conditions that help students thrive (Berger & Braxton, 1998). These factors influence everything from classroom policies to teaching styles, all of which shape how students interact with the material and whether they succeed in mastering it (Tinto & Pusser, 2006). Using Tinto's theory (Tinto, 1975; Tinto, 1993) as the foundation for our study allowed us to take a broad, meaningful look at the different variables that can affect student success—especially in demanding courses like animal nutrition (see Figure 1). By identifying which factors matter most, we can design targeted interventions and support systems that promote academic achievement and help students persist in their educational goals (do Carmo Nicoletti, 2019).

Figure 1

Theoretical Framework that Guided the Examination of Factors that Impact Success in an Animal Nutrition Course



Note. Adapted from "Dropout from Higher Education: A Theoretical Synthesis of Recent Research," by V. Tinto, 1975, *Review of Educational Research, 45*(1), p. 95 (https://doi.org/10.2307/1170024). Copyright 1975 by the American Educational Research Association. And *Leaving college: Rethinking the causes and cues of student attrition* (2nd ed.) by V. Tinto, 1993, The University of Chicago Press, p.114. Copyright 1993 by the University of Chicago.

Purpose and Objectives

The purpose of our study was to identify factors that predict academic success in an undergraduate animal nutrition course at a large land-grant university. Specifically, our study sought to determine how student demographics, prior academic achievement, agricultural proximity, and preparedness behaviors relate to student performance.

The following research objectives guided our study:

1. Do demographics predict academic success in an animal nutrition course?
2. Does a student's prior academic success predict academic success in an animal nutrition course?
3. Does a student's agriculture proximity predict academic success in an animal nutrition course?
4. Does a student's behavior and preparedness predict academic success in an animal nutrition course?

Methods

Population

The participants in our study consisted of 1,097 students enrolled in an animal nutrition course between the years 2022 and 2023. The demographic characteristics and academic backgrounds of these students were examined to understand how various predictors influenced academic success (see Table 1). Most participants identified as female (77.4%), while males comprised 22.6% of the sample. Hispanic students made up 28.9% of the sample, while 61.1% identified as White. Other ethnic groups included Black (3.1%), Native American (3.2%), and smaller percentages of students from other backgrounds. Most students were born between 2001 and 2003, with 28.3% born in 2003 and 27.3% born in 2002. Students born before 1999 accounted for only 11.8% of the population. Regarding academic classification, seniors comprised the largest group at 41.6%, followed closely by juniors at 40.7%, and sophomores representing 14.8%. Most students (56.9%) completed the course in the Fall semester, while 43.1% enrolled in the Spring. Enrollment was nearly equal between 2022 (50.8%) and 2023 (49.2%). Students identifying as first-generation college students made up 28.8%, whereas 69.6% reported having at least one parent with a college background. The university honors program students represented 6.1%, highlighting a high-achieving subgroup within the course. Only 0.3% of students identified as an athlete, indicating a minimal overlap between this course's athletic populations. Regarding academic major representation, students majoring in Animal Science made up the largest group, accounting for 62.6% of the sample. Following them were students in Biomedical Sciences at 21.1%. Other majors that were represented included Biology (2.3%), Poultry Science (0.8%), and Zoology (2.6%). Additionally, 10.5% of the students were enrolled in various other majors, highlighting the course's interdisciplinary nature.

Table 1

Student Profile Frequencies for Study Examining Factors that Impact Success in an Animal Nutrition Course, n = 1097

Variable	Frequency %	Final Course M
Sex		
Female	77.4%	81.52
Male	22.6%	81.69
Ethnicity		
Hispanic	28.9%	78.53
White	61.1%	82.79
Black	3.1%	82.35
Other	7.0%	86.86
Year of Birth		
1998-2000	11.8%	75.74
2001	22.4%	81.25
2002	27.3%	81.81
2003	28.3%	82.14
2004	10.1%	83.14
Year Course was Taken		
2022	50.8%	81.60
2023	49.2%	81.52
Semester Course was Taken		

Variable	Frequency %	Final Course M
Fall	56.9%	82.00
Spring	43.1%	80.97
Classification		
Sophomore	14.8%	75.40
Junior	40.7%	81.74
Senior	41.6%	83.34
Honors		
Involved	6.1%	90.60
Not Involved	93.9%	80.97
Athlete		
Athlete	0.3%	80.06
Not an Athlete	99.7%	81.56
First Generation		
Yes	28.8%	77.99
No	69.6%	83.11
Major		
Animal Science	62.6%	80.63
Biomedical Science	21.1%	84.44
Biology	2.3%	87.86
Poultry Science	0.8%	77.59
Zoology	2.6%	82.82
Other Discipline	10.5%	79.94

Research Design

Our study employed a quantitative, correlational, non-experimental research design using existing course data across four semesters of an undergraduate animal nutrition course. Our goal was to examine the relationship between multiple student-related variables and course performance.

Data Collection

Data was extracted from the course's online learning management system and university records with the support of the course instructor. Demographic data was collected from institutional records and matched to academic performance and preparedness data (e.g., quiz scores, homework completion, attendance), which were retrieved directly from course records. Following Institutional Review Board guidelines, all data was anonymized, and profile categories with five or less students were removed or collapsed to maintain anonymity. Data was stored on a secure server.

Data Analysis

To begin the analysis, descriptive statistics were calculated to give a general overview of the students' demographic and academic backgrounds. From there, Pearson product-moment correlations were used to examine how each of the independent variables, such as demographics, prior academic performance, agricultural proximity, and preparedness behaviors, are related to the final course score, which served as our dependent variable. To dig deeper into what predicts academic performance, a multiple linear regression

analysis was conducted. Before interpreting the results, several assumptions were checked to make sure the model was valid and reliable.

First, we tested for linearity by using scatterplots, which showed that the relationships between our predictor variables and final course score were reasonably linear. Next, we assessed whether the residuals (or errors) were independent by calculating the Durbin-Watson statistic. The result fell between 1.5 and 2.5, which is considered an acceptable range, suggesting that concerning autocorrelation did not exist in the data. We also looked at homoscedasticity—whether the residuals had constant variance—by reviewing a scatterplot of standardized residuals against predicted values. Since the plot didn't show any clear patterns, we concluded that this assumption was met. To make sure our predictors weren't too closely related to each other, we checked for multicollinearity using Variance Inflation Factor (VIF) scores. All VIF values were below 5.0, meaning there was no issue with collinearity among the variables. Finally, we verified that the residuals followed a normal distribution. This was done by reviewing a normal probability plot (P-P plot) and a histogram of the standardized residuals, both of which supported the assumption of normality. All analyses were conducted using IBM SPSS Statistics, Version 28, and a significance level of $\alpha = .05$ was used to determine statistical significance.

Findings

The first research question explored whether demographic variables could predict academic success in an animal nutrition course. The demographic variables examined included student classification, honor status, race, sex, year of birth, semester of enrollment, athlete status, and specific interactions such as the combination of year and semester of course enrollment, and the interaction between race and first-generation status. The interaction of the year and semester tested whether the timing of course enrollment influenced success, while the interaction term for race and first-generation status examined whether these combined factors could predict academic performance.

The descriptive statistics for the variables used for this question are outlined in Table 1. Additionally, the analysis of majors revealed differences in performance across academic disciplines. Students majoring in Biology achieved the highest average scores, followed by those in Biomedical Sciences, and then Zoology. Students in Animal Science, the largest major group, scored lower on average, while students in Poultry Science had the lowest mean scores (see Table 2).

Table 2

Major Groups Descriptive Statistics for Final Grades, n = 1097

Major Group	n	Final Grade	
		M	SD
Animal Science	687	80.63	12.44
Biomedical Science	232	84.44	10.89
Biology	25	87.86	7.87
Poultry Science	9	77.59	6.78
Zoology	29	82.82	12.12
Other Discipline	115	79.94	10.74

Correlation analysis revealed several significant relationships. Students who took the course later in their college careers, particularly juniors and seniors, tended to score higher ($r = .207$, $p < .001$). Additionally, honors students performed better overall ($r = .203$, $p < .001$). On the other hand, first-generation students faced more challenges, scoring lower than their peers ($r = -0.190$, $p < .001$). There was

also a small but significant correlation between ethnicity and final scores ($r = .157$, $p < .001$). An interesting trend was observed regarding birth year, which showed a weak positive correlation ($r = .081$, $p = .005$); younger students slightly outperformed older students, although the difference was minimal. Conversely, some factors did not significantly impact student performance. Sex had no substantial effect on final scores ($r = .012$, $p = .355$), indicating that male and female students performed similarly. Athletic status also appeared to have no influence ($r = .011$, $p = .362$). Lastly, the timing of the course, whether taken in the fall or spring ($r = -0.047$, $p = .066$) or a specific year ($r = -0.014$, $p = .330$), did not significantly affect scores.

The overall model was statistically significant, explaining 15.9% of the variance in final scores ($R^2 = 0.159$, Adjusted $R^2 = 0.150$, $F(10, 1013) = 19.08$, $p < 0.001$). In the coefficient analysis, as seen in Table 3, classification was a strong positive predictor of student performance, with students scoring higher who were further along in their academic careers. Additionally, honors status significantly influenced scores, with honors students earning an average of approximately eight points more than non-honors students. However, first-generation students faced a notable disadvantage, scoring about five points lower on average. Ethnicity also had a small impact, as minor variations in scores were observed across different ethnic groups. The year in which the course was taken had a slight negative effect on performance, suggesting that students in later years may have encountered different challenges or instructional changes. In contrast, the year of birth positively influenced scores, with younger students achieving better results. Other variables did not significantly predict final scores, including athlete status, sex, and the interaction between the year and semester enrolled. Similarly, the interaction between race and first-generation status approached significance but did not reach the required threshold (see Table 3). The semester the course was taken was excluded from the multiple regression analysis due to a high VIF.

Table 3

Regression Results for Demographic Variables with Final Grade as Dependent Variable, n =1024

Variable	Beta		Significance (p)
	Standardized	Unstandardized	
Sex	0.000	-0.007	0.994
Ethnicity	0.093	0.335	0. 004
Classification	0.293	4.755	$p < .001$
Year of Birth	0.224	2.104	$p < .001$
Honor	0.166	8.029	$p < .001$
Athlete	0.035	9.369	0.227
First Generation	-0.190	-4.961	$p < .001$
Year Course was Taken	-0.072	-1.704	0.031
Year and Semester Course was Taken Interaction Term	0.037	0.000	0.269
Ethnicity and First-Generation Interaction Term	0.074	0.098	0.077

Note. Seventy-three students were unable to be included due to missing data or to maintain anonymity.

For the hypothesis testing, sex had a Sig. value of 0.994, which is greater than 0.05, meaning the null hypotheses were accepted, and there was no significant change in final scores due to sex. Ethnicity had a Sig. value of 0.004, which is less than 0.05, so the null hypothesis was rejected, indicating that ethnicity slightly influenced final scores. Classification when taking animal nutrition had a Sig. value of < 0.001, leading to rejecting the null hypothesis and confirming that higher classifications (e.g., juniors and seniors) were associated with better performance. Year of birth also had a Sig. value of < 0.001, leading to rejecting the null hypothesis and showing that students born in later years scored higher. Honor status had a Sig.

value of < 0.001, which led to rejecting the null hypothesis and demonstrated that honors students performed significantly better. Athlete status had a Sig. value of 0.227, meaning the null hypothesis was not rejected, and no significant change in final scores was observed due to athlete status. First-generation status had a Sig. value of < 0.001, leading to rejecting the null hypothesis and revealing that first-generation students scored lower. The year the course was taken had a Sig. value of 0.031, which is less than 0.05, so the null hypothesis was rejected, indicating a slight negative impact on final scores depending on the year of enrollment. The semester the course was taken had a Sig. value of 0.269, meaning the null hypothesis was not rejected, showing no significant effect. Finally, the interaction term for ethnicity and first-generation status had a Sig. value of 0.077, meaning the null hypothesis was not rejected, and no significant effect on final scores was observed.

The second research question examined various measures of prior academic success- such as high school rank, first year college GPA, and prerequisite course grades. The primary objective was to identify which academic performance metrics are reliable indicators of future success, providing valuable insights for improving student outcomes and supporting academic preparation strategies.

For the descriptive statistics, grades in introductory animal science were measured on a 1-to-6 scale (1 = F, 6 = A) as seen in Table 4. First-year college students' GPA were measured on a standard 1-to-4 scale (1 = D, 4 = A) (see Table 4). Correlation analysis revealed that first-year college students' GPAs had the most substantial positive relationship with final scores (r = 0.45, p < .001), indicating that students with higher GPAs tended to perform better overall. High school class rank showed a weak negative correlation (r = -0.064, p = .05), suggesting that higher rankings (lower numerical values) were associated with slightly better final scores, although the effect was small. Grades in introductory animal science had a moderate positive correlation with final scores (r = 0.484, p < .001), meaning students who performed poorly in this course were likely to have lower final scores.

Table 4

Descriptive Statistics for Final Grades and Prior Academic Variables, n = 663

Variable	Final Grades	
	M	SD
High School Rank	52.45	94.23
First Year College GPA	3.58	0.53
Introductory Animal Science Course	5.43	0.79

Note. Data was only available for 663 of the 1097 students due to missing data or to maintain anonymity.

The regression analysis confirmed these findings, as seen in Table 5. The model explained 27.9% of the variance in Final Scores (R^2 = 0.279, Adjusted R^2 = 0.276) and was statistically significant (F(3, 659) = 84.98, p < .001). Among the predictors, first year college GPA had the strongest positive impact, showing that higher GPAs were strongly linked to higher final scores (see Table 5). Grades in introductory animal science also had a significant positive effect, demonstrating that better performance in this course contributed directly to better final scores (see Table 5). High school class rank, however, did not have a significant effect (see Table 5).

Table 5

Regression Results for Prior Academic Variables with Final Grade as Dependent Variable, n = 663

Variable	Beta		Significance (p)
	Standardized	Unstandardized	
High School Rank	-0.096	-0.013	0.004
First Year College GPA	1.019	5.465	$p < 0.001$
Introductory Animal Science Course Grade	0.351	5.637	$p < 0.001$

Note. Data was only available for 663 of the 1097 students due to missing data or to maintain anonymity.

In hypothesis testing, first year college GPA and grades in introductory animal science both had Sig. values below 0.001, leading to the rejection of their null hypotheses and confirming their significant positive effects on final scores, since these values are less than the 0.05 threshold. The high school class rank had a Sig. value of 0.004, leading to the rejection of their null hypotheses and confirming their significant positive effects on final scores.

The third research question explored the connection between students' proximity to agriculture and their academic success in an animal nutrition course. Proximity to agriculture was assessed using rural-urban commuting area (RUCA) codes, which categorize geographic regions based on their rural or urban characteristics. FFA and 4-H program availability was also assessed. These measures aimed to determine how exposure to agricultural environments might influence academic performance. In the preliminary analysis, metropolitan students had the highest average final scores, followed closely by small-town students, as seen in Table 6. Micropolitan students scored slightly lower (Table 6). However, Pearson correlations revealed that the relationships between these variables and final scores were very weak. The student's background—whether from a rural or urban area (as defined by RUCA groups)—showed almost no relationship with final scores (r = -0.008, p = .400), suggesting that students from diverse areas performed similarly. Likewise, the rurality codes reflected no significant correlation (r = 0.003, p = .465), and the interaction between FFA/4-H availability and RUCA classifications also showed little connection (r = -0.005, p = .436). Therefore, these factors were not strong predictors of academic success. Interestingly, access to FFA or 4-H programs in high school showed a slight negative correlation with final scores (r = -0.038, p = .107), although this relationship was not statistically significant.

Table 6

RUCA Group Code Final Grade Means and Standard Deviations, n = 1067

Variable	Final Grades	
	M	SD
RUCA group code		
Metropolitan	81.83	11.98
Micropolitan	78.95	11.74
Small Town	81.68	10.95

Note. Data was only available for 1067 of the 1097 students due to missing data or to maintain anonymity.

The regression analysis confirmed these weak relationships, showing that these variables were not significant predictors of final scores. The model explained only 0.3% of the variance in final scores (R^2 = 0.003) and was not statistically significant ($F(4, 1054) = 0.831$, p = 0.506). Looking closer, RUCA groups

showed no significant effect, as seen in Table 7. Similarly, rurality code, FFA/4H availability, and the interaction between RUCA groups and FFA/4H availability all failed to significantly impact final scores (see Table 7).

Table 7

Regression Results for Agriculture Proximity Variables with Final Grade as Dependent Variable, n =1059

Variable	Beta		Significance (p)
	Standardized	Unstandardized	
RUCA Group	-0.138	-2.701	0.209
FFA/4H Availability in High School	-0.054	-1.723	0.206
RUCA Group and FFA/4H Availability Interaction Term	0.047	0.269	0.632
Rurality Code	0.097	0.562	0.472

Note. Data was only available for 1059 of the 1097 students due to missing data or to maintain anonymity.

In terms of hypothesis testing, none of the variables had p-values below the 0.05 threshold, meaning we cannot reject the null hypothesis for any of the predictors. This suggests that rurality classifications, FFA/4H program availability, and their interaction do not meaningfully influence academic performance in this course. The findings highlight the limited role these factors play, as reflected in the negligible correlations and low R^2 value. Instead, this points to other factors being more influential in determining student success.

The fourth research question investigated the impact of students' behaviors and preparedness on their academic success in an animal nutrition course. Behaviors such as completing composite writing assignments and participating in extra credit activities tied to attendance were examined to determine their influence on final grades. The study aimed to understand how students' effort and preparedness contributed to their overall academic performance by focusing on these engagement-related factors. Our study explored how students' behaviors and preparedness impact their success in an animal nutrition course, focusing on whether completing assignments and participating in extra credit activities predict better grades. In the preliminary analysis, we examined the relationship between composite writing assignments, extra credit participation, and final scores. On average, students had a wide range of engagement on their writing assignments and reflected consistent attendance through their extra credit quizzes, as seen in Table 8. According to Pearson correlations, there was a modest but significant link between writing assignments and final scores ($r = 0.130$, $p < 0.001$), while extra credit showed a stronger connection ($r = 0.407$, $p < 0.001$), suggesting that regular participation helped boost grades.

Table 8

Descriptive Statistics for Final Course Grades and Preparedness Variables, n = 726

Variable	Final Grades	
	M	SD
Composite Writing Assignments Score	163.33	132.31
Extra Credit Quiz Count	9.89	2.17

Note. Data was only available for 726 of the 1097 students due to missing data or to maintain anonymity.

In the deeper analysis, the regression model showed the R^2 value was 0.185, meaning that 18.5% of the variance in final scores was explained by composite writing assignments and extra credit participation ($F(2, 723) = 82.049$, $p < 0.001$). Writing assignments had a small but meaningful impact—each point increase in assignments led to a 0.01-point bump in the final grade, as seen in Table 9. Extra credit had a bigger effect, with each point adding 1.76 points to the final score (see Table 9). These results highlight that students who stay engaged through assignments and complete extra credit quizzes tend to do better academically, showing the value of consistent effort and participation in the course.

Table 9

Regression Results for Preparedness Variables with Final Grade as Dependent Variable, n = 726

Variables	Beta		Significance (p)
	Standardized	Unstandardized	
Composite Writing Assignments Score	0.138	0.01	$p < 0.001$
Extra Credit Quiz Count	0.410	1.76	$p < 0.001$

Note. Data was only available for 726 of the 1097 students due to missing data or to maintain anonymity.

For hypothesis testing, both composite writing assignment scores, and extra credit quiz count had significant p-values ($p < 0.001$). Since these values are less than the 0.05 threshold, the null hypothesis was rejected for both variables. This indicates that changes in the final scores are significantly influenced by the students' performance in composite writing assignments and participation in extra credit quizzes.

Discussion of Findings

Our study provides valuable insights into factors contributing to student success in an animal nutrition course at a large educational university. The findings highlight the influence of academic preparation, demographics, and student engagement. Prior academic performance emerges as a key predictor of success, with first year college GPA and grades in foundational courses, such as introductory animal science, serving as important indicators. This finding supports Tinto's Model of Student Departure (Tinto, 1975), which suggests that well-prepared students have the knowledge and strategies necessary to tackle challenging science-based courses (Berger & Braxton, 1998). Student behaviors also play a significant role; those who attended classes regularly, performed well on writing assignments, and utilized extra credit opportunities tended to perform better overall (Tinto & Pusser, 2006). This underscores the importance of students engaging and actively participating in learning. Students who effectively managed their time and remained consistently involved achieved more substantial course outcomes, emphasizing that learning is most effective when it is a continuous, active effort (Tinto & Pusser, 2006).

Surprisingly, the proximity to agricultural settings did not significantly predict academic success. This finding challenges the assumption that hands-on agricultural experience automatically leads to better academic performance in an animal nutrition course (Boerngen & Rickard, 2020). Instead, the results indicate that structured academic preparation may be more impactful than experiential learning, mainly when dealing with complex content in courses like animal nutrition (Beck & Roosa, 2020). To better understand the impact of hands-on agricultural experience, future research should seek to better identify agriculture proximity. For example, investigating the impact of involvement in FFA in high school, instead of looking to see if their school offered it, would be valuable.

Key factors for student success include academic preparation, regular class attendance, and strong assignment performance. Offering consistent foundational courses in science and agriculture is recommended to better equip students. Encouraging consistent attendance and active participation in assignments should be a top priority (Beck & Roosa, 2020). Our findings show that students who attend classes regularly and engage with their assignments generally achieve better outcomes; thus, it is important for faculty to reward this behavior in order to encourage it. Institutions can support this by fostering interactive learning environments, providing timely feedback, and promoting accountability (Beck & Roosa, 2020). Furthermore, tailored supplemental material, peer mentoring, and expanded tutoring programs can help students navigate academic and social challenges more effectively (Burk et al., 2013). Agricultural education programs may also want to reconsider their admissions criteria by emphasizing academic performance and learning potential rather than agricultural experience. This shift can ensure that students are adequately prepared for rigorous courses and long-term success (Burk et al., 2013). Supplemental materials can significantly benefit students lacking foundational knowledge in an animal nutrition course. Resources such as study guides, instructional videos, and practice quizzes can reinforce key concepts and address learning gaps (Beck & Roosa, 2020). By providing students with additional tools to review important content outside of class, instructors can equip students to stay on track with their courses. This support is invaluable for those struggling with challenging topics, as it promotes a better understanding of the material and enhances overall academic performance (Mebert et al., 2020).

Our study highlights that student success extends beyond academics and involves the integration of academic, behavioral, and social support. Schools should implement effective strategies that address the complete student experience (Mebert et al., 2020). This approach includes offering personalized, data-driven advising, providing focused academic assistance, and fostering an environment where students feel connected and supported (Kim et al., 2019). By adopting this comprehensive strategy, institutions can close gaps and help students succeed in agricultural education and beyond.

Contribution to Theory

Our findings reaffirmed several elements of Tinto's Model of Student Departure (Tinto, 1975), particularly the significance of academic integration in predicting student success. Prior academic performance, such as GPA and grades in prerequisite courses, emerged as strong predictors of success, supporting Tinto's assertion that students with a solid academic foundation are better equipped to handle challenging coursework (Tinto & Pusser, 2006). This foundation enhances their understanding and resilience in complex subjects. Our study also extended Tinto's theory by demonstrating that academic integration alone is insufficient for success in specialized courses like animal nutrition (Tinto & Pusser, 2006). Demographic factors, including sex, race, ethnicity, and first-generation status, played a small role, highlighting the need for social integration as a complementary factor. Students who faced overlapping challenges often encountered barriers that traditional academic metrics could not fully capture, highlighting the importance of fostering inclusive and supportive institutional environments (Beck & Roosa, 2020).

Tinto's ideas about academic and social integration were further validated by the behaviors observed in students. Those who actively engaged in their courses—through consistent attendance, timely assignment completion, and participation in extra-credit opportunities—tended to perform better academically. This supports Tinto's claim that meaningful engagement within the academic environment is essential for student persistence (Berger & Braxton, 1998). Interestingly, the lack of a significant relationship between agricultural proximity and academic success suggests that prior experience alone does not guarantee success. Instead, structured academic preparation appears to be more important in fostering student achievement (Mebert et al., 2020). By situating these findings within Tinto's framework, our study emphasizes the interconnected roles of academic preparedness, social integration, and institutional support (Berger & Braxton, 1998). Together, these factors create an environment that promotes student persistence

and success in higher education, particularly in demanding fields like animal science and nutrition (Berger & Braxton, 1998).

Contributions to the Discipline

These findings highlight the critical role of student engagement and academic support in preparing future professionals for animal science and agricultural professions in general. While attendance matters, the results show that completing assignments successfully and preparation for classes are equally important. This could point to the need for more interactive and application-focused teaching approaches in animal science courses (Kim et al., 2019). Integrating hands-on activities, real-world problem-solving, and collaborative discussions can deepen students' understanding of the material and demonstrate its relevance to their future careers (Mebert et al., 2020). Our study also emphasized the importance of supporting students who may struggle academically. Resources like study guides, instructional videos, and practical examples can help close knowledge gaps and foster meaningful learning experiences (Kim et al., 2019). By combining engaging, interactive teaching methods with targeted academic support, educators can prepare well-rounded graduates ready to tackle the varied challenges of the animal science industry (Mebert et al., 2020).

Recommendations for Future Research

Future research should take a broader approach by studying multiple institutions to see if the findings are held across different types of universities, including diverse samples, agricultural and non-agricultural courses, and courses with varying complexity. This would help make the results more applicable as specific strategies are studied to assist students. Long-term studies would also be beneficial as these could track students in animal science programs to understand their academic journeys and career paths over time. This approach would allow the evaluation of how specific interventions, like study skills workshops, coaching, and peer-led study groups, impact student success (Mebert et al., 2020). Additionally, looking into learning styles, motivation, socio-economic background, and family education levels could provide deeper insights into what influences performance (Beck & Roosa, 2020). Finally, employing qualitative methods like interviews, focus groups, and case studies could offer a richer understanding of students' experiences. This approach could uncover students' unique challenges and opportunities.

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