Factors Associated with Course Withdrawal and Final Course Grade in an Introductory Animal Science Course[1]

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Abstract

During a time of changing student demographics, it is necessary to examine factors associated with student success so that faculty can provide an environment supportive to student learning. The objective of this study was to identify factors associated with course withdrawal and course grade percentage in an introductory animal science course. Data were collected on 405 participating University of Kentucky students in two semesters of Domestic Animal Biology. During the first several weeks of the semester, students completed a demographic survey, background knowledge test and California Critical Thinking Skills Test (CCTST). Multiple logistic regression found that (1) high school GPA below 3.5, (2) residing in Kentucky longer than out-of-state and (3) being a non-traditional student were associated with increased odds of course withdrawal when adjusted for other variables within the model ($p<0.05$). Multiple linear regression found that (1) having a high school GPA above 3.5, (2) CCTST percentile rank in the top third, (3) attending private high school/homeschooling, (4) participating in agricultural clubs, or (5) coming from a suburban or rural non-farm home were associated with higher adjusted mean course grade percentages ($p<0.05$). Further research is needed to identify reasons for associations and develop strategies to assist at-risk students.

Introduction

In recent years, there has been a shift in the demographics of students who enroll in animal science courses (Buchanan, 2008). More females, individuals from urban/suburban communities, non-traditional students and students with interest in companion animals or equids rather than other livestock species, are enrolling in animal science programs (Buchanan, 2008; Peffer, 2011; Reiling et al., 2003). Knowledge of how these factors are associated with student success will help departments to meet the evolving needs of students.

A small number of variables have been examined for association with course grade in college agricultural courses, with mixed conclusions. Conflicting results have been obtained for gender and association with animal science course grade. One study found no association between course grade and gender (Peffer, 2011), while other studies found that females obtained higher grades than males (Lancaster and Robinson, 2011; McMillan et al., 2009; Soberon et al., 2012). Varying results were also found by major and course grade in agricultural courses. Course grade was higher for animal science majors when compared to other agriculture majors in an introductory animal science course (Peffer, 2011), while other studies found no effect of major on introductory plant science or animal science courses (Lancaster and Robinson, 2011; McMillan et al., 2009; Soberon, et al. 2012). Whether students are in-state or out-of-state residents may also play a role in course performance. One study found non-residents of New York to have higher course grades in an Animal Nutrition class, when compared with residents (Soberon et al., 2012).With changing student demographics in agriculture courses from rural to more urban/suburban; it is also of interest to determine how community type affects student success.

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One study found that having a farm background or previously taking agricultural classes had minimal effect on final course grade in introductory agriculture classes (Greene and Byler, 2004). Despite the rising numbers of nontraditional students in agricultural courses, academic success of these students has been the subject of limited study. Researchers found a trend (p=0.08) for a positive correlation between age and final course grade in an introductory plant science course (Lancaster and Robinson, 2011). High school GPA is commonly considered during the college admissions process as a potential indicator of student success in college. In one study, high school GPA was associated with year-end GPA for freshman agriculture students (Garton et al., 2002). Additional research is needed to determine which factors, if any, are associated with course grade in introductory animal science courses.

Few studies have examined factors associated with course withdrawal either in agriculture courses or in general. Retention at the program or university level has been examined in more detail. One study found that high school GPA was not associated with college of agriculture retention (Heitstuman and Cvancara, 1992), while another found it to be a predictor of continuing from freshman to sophomore year in a college of agriculture (Garton, 2001). No association was found between taking agricultural courses in high school and college of agriculture retention (Heitstuman and Cvancara, 1992), while another study found it to be associated with intent to complete an agricultural degree (Dyer et al., 2002). Experience in agriculture was another predictor of intent to complete an agricultural degree (Dyer et al., 2002). Students who participated in college clubs had significantly higher college of agriculture retention rates when compared to those who did not (Heitstuman and Cvancara, 1992). If variables of interest were examined for combined effect on individual course completion status or course grade, more information would be available to assist faculty members with maintaining and updating animal science courses.

The purpose of this study was to identify factors associated with student success in Domestic Animal Biology (ASC 101), an introductory animal science course taught in the fall semester at the University of Kentucky. The objectives of the study were to describe characteristics of ASC 101 students, as well as to identify variables associated with course completion status and final course grade.

Materials and Methods

Study Sample

Data were collected on participating students enrolled in the fall 2010 and fall 2011 semesters of ASC 101. This is a 3-credit introductory course required for Animal Science, Equine Science and Management and Agricultural Education majors. The course includes both lecture and laboratory components. Students in this course are graded by performance on exams, quizzes, homework assignments and laboratory exercises. The course material covered includes a broad survey of anatomy, physiology, nutrition, reproduction, genetics and behavior for major livestock species. A total of 425 students enrolled in ASC 101 during the two semesters. Students were excluded if they did not wish to participate, or if they were legally considered to be minors. Following approval by the University of Kentucky Institutional Review Board, students were provided with a cover letter detailing study procedures. Students who did not wish to participate were able to opt out of the study by signing and returning the cover letter. After 20 students were excluded from the study, 405 students remained for course withdrawal analyses. Of the 405 students who were eligible and willing to participate, 47 dropped or withdrew from the course. Thus, 358 students remained for course grade percentage analyses.

Instruments

Students completed a demographic survey, background knowledge test and the California Critical Thinking Skills Test (CCTST) during the first several weeks of the semester. The demographic survey consisted of 15 questions about previous agricultural experience, education and general demographic information. The background knowledge test consisted of 20 questions that graduates of the Animal and Food Science (AFS) program would be expected to answer correctly and focused on nutrition, anatomy and animal production. Students took the 2009 version of the CCTST. This test consisted of 34 non-discipline specific multiple choice questions designed to measure students' ability to think critically (Facione, 2009). This test was normed using a sample of undergraduate students and was reported to have a Kuder-Richardson-20 internal consistency estimate of 0.80 for college students sampled from a large public university (Lambert and Martin, 2010). Outcomes of this study were final course grades and course completion status and these items were tabulated at the conclusion of the semester. Variables were examined for association with these outcomes through statistical analyses.

Data Analysis: Course Completion

Using SAS (version 9.2), characteristics of the sample categorized by outcome (dropping or withdrawing from the course versus receiving a grade) were examined (Tables 1 and 2). Descriptive statistics such as mean, median, minimum value and maximum value were

Table 1. Characteristics of Fall 2010 and Fall 2011 ASC 101 students by course completion status. Variables listed in this table were not included in the final models for course completion status or final course grade percentage.

Characteristic	Completed Course	Dropped or Withdrawn	Combined
Gender			
Male	67(19.7%)	6(17.1%)	73(19.5%)
Female	2/3(80.3%)	29(82.9%)	302(80.5%)
Missing			30
Ethnicity			
Caucasian	209(61.3%)	21(58.3%)	230(61.01%)
Other	19(5.6%)	4(11.1%)	23(6.1%)
Choose not to respond	113(33.1%)	11(30.6%)	124(32.9%)
Missing			28
Degree			
Animal Science	152(42.3%)	17(37.0%)	169(41.7%)
Equine Science and Management	138(38.4%)	17(37.0%)	155(38.3%)
Other	69(19.2%)	12(26.1%)	81(20.0%)
Missing			0
High School Agriculture Classes[x]			
No	246(72.6%)	22(62.9%)	268(71.7%)
Yes	93(27.4%)	13(37.1%)	106(28.3%)
Missing			31
College Agriculture Classes[x]			
No	236(69.6%)	20(57.1%)	256(68.5%)
Yes	103(30.4%)	15(42.9%)	118(31.6%)
Missing			31
Background Knowledge Test Percent Correct[x]			
0-49%	159(46.9%)	21(58.3%)	180(48.0)
50-100%	180(53.1%)	15(41.7%)	195(52.0)
Missing			30

x: $p<0.25$ for chi-square test of independence for that variable by course completion status.

calculated for the continuous variable (age). Frequencies and percentages were calculated for nominal variables. The chi-square test of independence or the Wilcoxon rank-sum test (for the "age" variable) was performed to analyze differences in outcome for each level of the variable (Tables 1 and 2). When examining the results of these statistical tests, a significance level of $p<0.25$ was used to choose variables for inclusion when building the multiple logistic regression model. After the first round of variable selection, the chi-square test of independence or Fisher's exact test were performed for categorical explanatory variables that were suspected of having overlapping variability. Multiple logistic regression was chosen as the best analysis to answer the research question because of the dichotomous nature of the outcome (withdrawing versus remaining in the course). The multiple logistic regression model was created by adding variables that noticeably improved the area under the receiver operator characteristic (ROC) curve and removing any that did not have a substantial effect on the model statistics. Model fit was assessed by the Hosmer-Lemeshow goodness-of-fit test. Variance inflation factors were checked through multiple linear regression and did not indicate multicollinearity (range: 1.00-1.05).

Data Analysis: Course Grade Percentage

For the multiple linear regression analysis, final ASC 101 course percentage was used as the response variable. Explanatory variables used were the same as shown in Tables 1 and 2. Data were plotted and chi-square tests of independence were performed to find associated variables. A multiple linear regression analysis was conducted and a final model was created through manual selection. Any variables that did not have a noticeable effect on R^2 were removed, except for "year," which was forced into the model. Variance inflation factors did not indicate multicollinearity (range: 1.06-1.68).

Results and Discussion

Instruments

Reliability of the background knowledge test was calculated using scores from the 2010 cohort. The Kuder-Richardson reliability index was 0.43, the split-halves reliability was 0.49 and the standard error of measurement was 1.95. In the future, increasing the number of questions or including questions that result in a larger spread of scores may help to improve the background knowledge test.

Characteristics of the Sample

Many students in the ASC 101 course were around 18 or 19 years of age, female, Caucasian, from Kentucky, had come from suburban/urban neighborhoods, attended public high school and achieved a high school GPA above 3.5 (Tables 1 and 2). Most of the students sampled were working towards an Animal Science degree and had not taken a previous agriculture class. About half (Table 2) of ASC 101 students had participated in an agricultural club. Major organizations that students were involved with include 4-H (105 students), FFA (94 students), equine breed or discipline associations (28 students) and Pony Club (18 students). The race and ethnicity variable was not included in any of the inferential analyses due to the large number of students who chose not to respond to that question (Table 1).

Table 2. Characteristics of Fall 2010 and Fall 2011 ASC 101 students by course completion status. Variables listed in this table were included in final models for prediction of either final course grade or course completion status (as denoted in parentheses).

Characteristic (Associated Outcome)	Completed Course	Dropped or Withdrawn	Combined
Course Grade			
n	358	47	405
Mean (SD	74.5% (14.4)	N/A	N/A
Median (Q1, Q3)	76.5% (68.3, 83.6)	N/A	N/A
Min, Max	2.3, 96.4	N/A	N/A
Age[x] (Course Withdrawals)			
n	351	45	396
Mean (SD)	19.2 (2.6)	21.2 (6.5)	19.5 (3.3)
Median (Q1, Q3)	18 (18, 20)	19 (18, 22)	18 (18, 20)
Min, Max	18, 50	18, 53	18, 53
Missing			9
Location Lived in for Longest Duration[x] (Course Withdrawals)			
Kentucky	184 (54.4%)	25(69.4%)	209(55.9%)
Other	154(45.6%)	11(30.6%)	162(43.3%)
Missing			31
Community Type (Course Grade)			
Urban	36(10.6%)	3(8.3%)	39(10.4%)
Suburban	148(43.5%)	17(47.2%)	165(43.9%)
Rural non-farm	62 (18.2%)	7(19.4%)	69(18.7%)
Rural farm	94(27.7%)	9(25.0%)	103(27.4%)
Missing			29
High School Type[x] (Course Grade)			
Public	272(80.2%)	33(91.7%)	305(81.3%)
Other	67(19.8%)	3(8.3%)	70(18.7%)
Missing			30
High School GPA[x] (Course Withdrawals and Grade)			
<2.99	27(8.0%)	6(17.6%)	36(9.7%)
3.00-3.49	111(33.0%)	15(44.1%)	126(33.8%)
3.50-4.00	198(58.9%)	13(38.2%)	211(56.6%)
Missing			32
Agricultural Club Involvement (Course Grade)			
No	174 (51.5%)	21 (58.3%)	195 (52.1%)
Yes	164 (48.5%)	15 (41.7%)	179 (47.9%)
Missing			31
CCTST Percentile Cateory (Course Grade)			
1-33rd percentile	98(28.7%)	12(33.3%	110(29.2%)
34-66th percentile	118(34.6%)	15(41.7%)	133(35.3%)
67-99th percentile	125(36.7%)	9(25.0%)	134(35.5%)
Missing			28
Year (Course Withdrawals, Forced for Course Grade)			
Fall 2010	179 (49.9%)	25 (54.4%)	204 (50.4%)
Fall 2011	180 (50.1%)	21 (45.7%)	201 (49.6%)

x: p<0.25 for chi-square test of independence for that variable by course completion status.

Associations between Independent Variables

Independent variables suspected of multicollinearity were checked for associations through chi-square tests of independence (Tables 1 and 2). An association was found between location lived in for the longest duration (in-state or out-of-state) and high school GPA (p<0.0001). Students who spent the most time outside of Kentucky were more likely to have a high school GPA above 3.5. Additionally, previously taking a college agriculture course was associated with taking a prior high school agriculture course (p=0.0001). Another association was found between background knowledge test score and participation in agricultural clubs. Students who had previously, or were currently participating in, agricultural clubs had higher background knowledge test scores than students who had no experience in agricultural clubs (p=0.026). This indicates that students who have participated in agricultural clubs enter the course with more prior animal science knowledge than students who have not participated in agricultural clubs. An association was also found between participating in an agricultural club and community type (p<0.0001). Students who were from a rural area and lived on a farm were more likely to have participated in an agricultural club when compared to students from other community types. Students from urban areas were most likely to have attended a private school or have been homeschooled (p=0.049).

Course Withdrawal

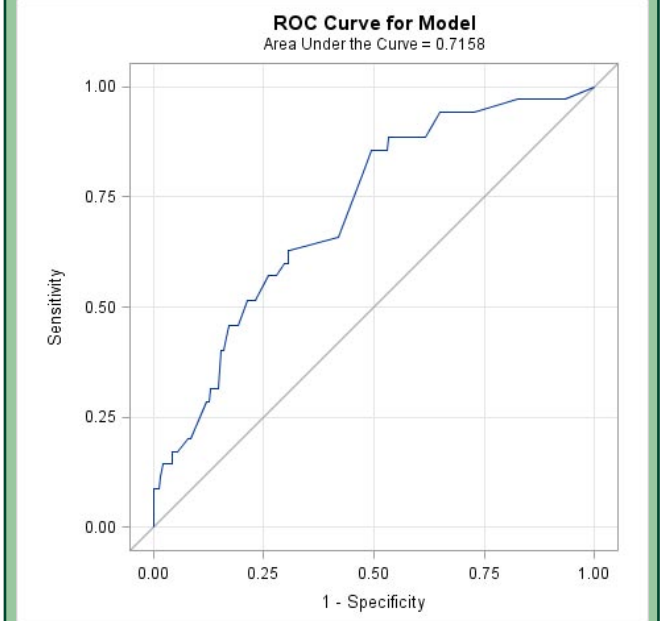
When variables were tested against course completion status using the chi-square test of independence (or the Wilcoxon rank-sum test for "age"), several variables met the criterion of p<0.25 to be offered to the multiple logistic regression model. For instance, a larger percentage of students who selected Kentucky as the location where they lived longest withdrew when compared with foreign/out-of-state state students (p=0.085). A disproportionate number of students who withdrew from the course had attended a public high school, rather than a school in the "other" category (private or homeschooled) (p=0.12). Additionally, a disproportionate number of students who withdrew from the course had a low high school GPA (p=0.036), low background knowledge test score (p=0.19), or had taken a previous agricultural course in either college (p=0.13) or high school (p=0.23). These variables were all offered to the multiple logistic regression model. The decision to include some variables with associations found during chi-square tests of independence was made after examining for effect on the area under the curve and the variance inflation factors.

The final model was:

Logit(probability of ASC 101 withdrawal)= α + ß1(year) + ß2(age) + ß3(HS GPA <3.0) + ß4(HS GPA 3.0-3.5) + ß5(location lived in: KY)

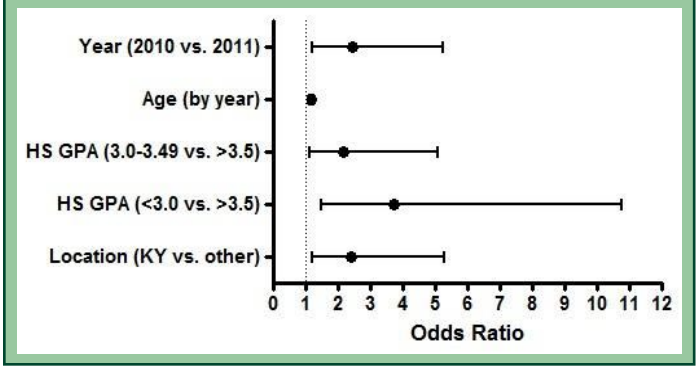
All variables included in the model (Table 2) were statistically significant at the α=0.05 level. The ROC curve displayed an area under the curve of 0.72 (Figure 1). Model fit was found acceptable by the Hosmer-Lemeshow test (p=0.15).

Figure 1. ROC curve for prediction of course withdrawal.



When accounting for other factors within the model, year was statistically significant (p=0.03). Students who took the course in 2010 were more likely to drop/withdraw when compared with students who took the course in 2011 (Figure 2). This probably resulted from differences in time of data collection during the semester. In 2010, assessment instruments were administered during the first laboratory course of the semester, while in 2011, due to scheduling conflicts, the instruments were administered in laboratory several weeks after the semester had begun. It is likely that some students who dropped the course in 2011 were not accounted for. Student age was also included in the model. Students who withdrew had a higher mean age when compared to those who remained in the course (Table 2). The odds of withdrawal increased for each one-year increase in age (Figure 2). Similarly, Murtaugh et al. (1999) found that non-traditional undergraduate students had lower retention rates. Bean and Metzner (1985) developed a model for non-traditional student attrition that included environmental variables (such as outside employment,

Figure 2. Adjusted odds ratio estimates and 95% Wald confidence limits from multiple logistic regression analysis for dropping/withdrawing from ASC 101. Variables include semester year, student age, high school GPA, and location lived in for the longest duration



family and finances), psychological variables, academic variables, background and intent to leave as factors influencing attrition.

Although students who withdrew were not surveyed to identify reasons for withdrawal, several students who had discussed withdrawing from the course with their instructor had cited time constraints due to family or career responsibilities. When compared with students who reported a high school GPA of 3.5 or higher, students with a high school GPA below 3.5 had higher odds of course withdrawal. This finding agrees with Garton et al. (2002), who found high school GPA to be a predictor of retention for freshman agricultural students. Students who performed well academically in high school may have been more prepared for ASC 101. It is suspected that some students may have dropped ASC 101 due to low course grade; however, course grade at time of withdrawal was not permanently recorded. The final variable included in the model was location lived in for the longest period of time. Students who had lived in Kentucky for the longest duration had higher odds of course withdrawal when compared with students who were from out-of-state or a foreign country. This contradicts findings of Murtaugh et al. (1999), who found in-state Oregon undergraduate students to be more likely to be retained when compared to out-of-state students. At the University of Kentucky, out-of state students may have more to lose by withdrawing from courses. Tuition and fees are approximately double for students who are considered to be out-of-state students and once classes begin, students are charged a portion of tuition at the time of dropping or withdrawing from the course. There also could be educational or socioeconomic factors not measured in this study that may differ between in-state and out-of-state students. Another limitation of the study was that students who dropped or withdrew had to be combined into one variable to permit statistical analyses. There are likely to be different reasons why students drop the course early during the semester versus

later; some students who are in danger of failing the course may drop it after mid-term grades are reported. Other researchers cited course grade, course difficulty, dislike of the instructor, low level of interest in the class, falling behind in class assignments and lack of time as major reasons for withdrawing from a college course (Hall et al., 2003). Variables not included in the model for course withdrawal due to lack of association were gender, degree, community type, high school type, taking high school or college agriculture classes, participating in agricultural clubs, CCTST percentile rank and background knowledge test score. Heitstuman and Cvancara (1992) also did not find an association between taking high school agriculture classes and retention.

Course Grade

When variables were tested for inclusion in the multiple linear regression models, effect on R^2 and variance inflation factors were examined closely to minimize issues due to multicollinearity.

The final model was:

ASC 101 Course Percentage = α + ß1(CCTST Percentile <34) + ß2(CCTST Percentile 34-66) + ß3(HS GPA <3.0) + ß4(HS GPA 3.0-3.49) + ß5(Urban) + ß6(Suburban) + ß7(Rural Non-farm) + ß8(Agriculture Clubs) + ß9(Public High School) + ß10(Year) + ε

When adjusted for other variables within the model and compared to students who obtained CCTST percentile ranks above 66, students with lower percentile ranks achieved lower mean ASC 101 course grades (Table 3). It appears that critical thinking is measured in the course and is reflected in course grades. Similarly, students who reported a high school GPA below 3.5 had lower adjusted mean course grades when compared to students with a high school GPA at or above 3.5. This finding supports the common use of high school GPA as a college acceptance criterion and agrees with the findings of Garton et al. (2002) as a predictor of GPA for freshman agriculture students. When compared with students from rural farms, students from suburban or rural non-farms had higher adjusted mean course grades. In another study by Siebert and colleagues (2006), no association was found between community type and GPA (or other academic motivation factors) for agricultural economics students. These results should help to alleviate concerns about performance of the increasing number of suburban and urban students in animal science courses. Additionally, students who were a current or past member in an agricultural-related club had higher adjusted mean course grades than students who had not participated in agricultural clubs. Students who were members of agricultural clubs also had higher background knowledge test scores (chi-square test of independence: p=0.026), so entering the course with more animal science knowledge may have given these students an advantage.

Many of the students who were from rural communities also participated in agricultural clubs; therefore, participating in an agricultural club may help to reverse the negative impact on course grades from living in a rural community. Lastly, students who attended public high schools had lower adjusted mean course grades when compared with students who attended private high school or were homeschooled. Factors that were not measured, such as socioeconomic status, educational level of parents, or quality of high school, may have had an effect within the community type and high school type variables. Barkley and Forst (2004) also found that college of agriculture freshmen who attended private high schools had higher first-semester GPAs than students who attended public high schools. Several variables, including age, gender, ethnicity, degree, location lived in for the longest duration, taking high school agriculture classes, taking college agriculture classes and background knowledge test score were not included in the model for course grade

Table 3. Results of multiple linear regression model for ASC 101 course grade percentage.

Variable	Adjusted Parameter Estimate	95% Confidence Interval	P-value
Intercept	80.08	75.51, 84.65	<0.0001
CCTST Percentile <34	-9.67	-12.88, -6.47	<0.0001
CCTST Percentile 34-66	-5.43	-8.39, -2.48	0.0003
CCTST Percentile >66	-	-	-
High School GPA <3.0	-6.74	-11.52, 1.96	0.0059
High School GPA 3.0-3.49	-5.24	-8.04, -2.44	0.0003
High School GPA >3.49	-	-	-
Urban	3.16	-1.49, 7.80	0.1826
Suburban	5.90	2.69, 9.11	0.0003
Rural Nonfarm	6.65	2.83, 10.48	0.0007
Rural Farm	-	-	-
Public High School	-3.78	-6.94, -0.61	0.0197
Agricultural Club Participation	4.45	1.74, 7.15	0.0013
Year: 2010 (forced)	-1.85	-4.35, 0.65	0.1459
R^2: 0.24			
Adjusted R^2: 0.21			

percentage due to lack of association. In agreement, Cole and Bokor (1989), also found no association between taking vocational agricultural classes in high school and GPA in college agricultural courses. Our results for gender agree with research by Peffer (2011), who found no association with course grade. Greene and Byler (2004) also found limited effect of taking high school agriculture courses on animal science course grade. Additionally, Pratt-Phillips and Schmitt (2009) found no association between major and course grade in an equine course. The variables that were included in our model account for 24% of the variance in course grade (Table 3), so there appears to be other unmeasured factors associated with final course grade percentage.

One potential limitation of using this model for prediction is that no two introductory animal science courses are exactly the same. Introductory animal science courses will have differences among professors, teaching assistants, course content, assignments, exam questions, laboratories, classroom environments and student populations. Additionally, there could be other important variables that were not surveyed here. Students were not surveyed upon withdrawing from the course, which could have provided additional information. Another study found number of absences to be associated with course grade (McMillan, 2009). Hours spent studying, course load, hours spent working, or ability to adjust to college life are other factors that could potentially affect course grade or course completion status. Attendance was not monitored in this course, but students were required to turn in laboratory sheets, quizzes and homework assignments during class time, so it is assumed that attendance would have a major impact on course grade. The main purpose of the models was to identify factors associated with successful course completion, rather than to predict course withdrawals or low grades. Identification of factors associated with course withdrawals and course grades should help to promote retention and student success for future animal science, agricultural education, and equine science students.

Summary

Both of the models developed in this study showed some ability to account for variability within course grade or course completion status. The multiple logistic regression model identified age, high school GPA, location lived in for the longest duration, and year as factors associated with course withdrawal. The multiple linear regression model found high school GPA, CCTST percentile rank, community type, high school type, and participation in agricultural clubs to be related to ASC 101 final grade. Future research should focus on reasons for associations between these variables and course grade or course completion status. Identification of variables associated with course grade and course completion status will assist faculty with course design and teaching strategies that will best support students who have varied backgrounds, skills, and goals.

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