Predictors of Freshman to Sophomore Retention in a College of Agricultural, Food and Life Sciences[1]

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Abstract

This study examined official university records for 3,257 new, first-semester freshmen entering the College of Agricultural, Food and Life Sciences (AFLS) between 1998 and 2015 to determine if selected student entry characteristics were related to sophomore retention. Two-thirds (67.0%) of freshmen students returned as AFLS majors in the fall of the following academic year. Students not returning to AFLS were almost equally divided between those not returning to the university (16.2%) and those returning to the university in non-AFLS majors (16.9%). Odds ratios (ORs) indicated every one-point increase in high school grade point average (HSGPA) was associated with a 245% increase in the likelihood of returning as an AFLS major, relative to dropping out. Being a first-generation college student increased the relative odds of dropping out by 66%. Agriculture majors (as contrasted to human environmental sciences majors) were 39% less likely to transfer out of AFLS, while students eligible for Pell grants were 28% less likely to transfer. Every one-point increase in composite ACT score was associated with a 6% increase in the likelihood of transferring out of AFLS. AFLS should increase retention efforts aimed at first-generation students, students with lower HSGPAs, human environmental sciences majors, and high ACT students.

Introduction

Nearly all agricultural, food, and natural resources (AFNR) industries are experiencing a shortage of qualified college graduates to fill available career opportunities (Goecker et al., 2015). Estimates through 2020 indicate colleges and universities will produce only 35,400 AFNR graduates each year to fill an estimated 57,900 annual positions (Goecker et al., 2015). The National Research Council (2009) and the STEM Food and Ag Council (2014), among others, have called for educational reform and strategic planning to meet AFNR employment needs.

The gap between the supply and demand for AFNR graduates is often thought of as a student recruitment issue (Rayfield et al., 2013), with significantly less attention given to the retention of currently enrolled AFNR students (Dunn et al., 2013). However, recruitment and retention efforts work in tandem to increase the supply of AFNR graduates by increasing the number of students entering the pipeline and by minimizing the loss of students as they move through the pipeline. Thus, increased attention must be devoted to AFNR student retention (Koon et al., 2009).

In addition to benefitting the AFNR industry, increased retention benefits students, universities, and society. College graduates enjoy increased income, more satisfying careers, and higher life satisfaction than their peers (Tinto, 2004). For individual universities, higher student retention positively impacts rankings, federal funding opportunities, alumni and public support, and program accreditation (Thammasiri et al., 2013). Finally, society benefits from higher retention and graduation rates through enhanced public discourse (Cantor, 2004), increased civic participation (Bradburn et al., 2006), and higher tax receipts (Day and Newburger, 2002).

Many universities employ somewhat selective admissions criteria to ensure that only those students with the potential to graduate are admitted (Wechsler, 2014). These criteria often include measures of academic performance such as high school grade point average (GPA), high school class rank, and ACT or SAT

[1]This work was supported, at least in part, by the USDA National Institute of Food and Agriculture, Hatch project 1007996 and the University of Arkansas, Division of Agriculture. The authors appreciate the assistance of personnel in the University of Arkansas Office of Institutional Research for providing the data set used in this project.
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scores (Allen et al., 2008; Garton et al., 2002). However, other non-academic factors may also influence student retention (Garton et al., 2002; Vernon, 1996). Gender (Broecke and Nicholls, 2007; Leppel, 2002), socioeconomic status (Attewell et al., 2011; Quinn et al., 2005; Smith and Naylor, 2001; Yorke and Longdon, 2008), admission year (Garton et al., 2002), familial college experience (Mattern et al., 2015), and students' sense of belonging to an institution (Hausmann et al., 2007) have been reported as predictors of student retention. In addition, research has shown that receipt of need-based financial aid, specifically Pell Grants, is associated with higher graduation rates for students from families with limited financial resources (Singell, 2004; Wei et al., 2009).

While each of these factors has been identified as a contributor to retention, Mattern et al. (2015) stated, *"With so many student-level, institution-specific, and environmental variables influencing retention in unique and complex ways, it becomes difficult for colleges and universities to synthesize all research findings on the factors related to retention"* (p. 19). This complex phenomenon has led to university- and college-specific investigation of retention factors. Within colleges of agriculture, Garton et al. (2002) found high school core GPA and ACT score to be the best predictors of first-year academic performance at the University of Missouri. In a later study, they found the best predictors of retention varied by year; for 1997 freshmen, a combination of high school core GPA and ACT score was the best predictor; for 1998 freshmen, high school core GPA alone was the best predictor (Garton et al., 2002). Garton et al. (2002) recommended that additional research be conducted to *"establish valid and reliable predictors of student success in colleges of agriculture"* (p. 54). By identifying variables associated with attrition, university administrators can target at-risk students more effectively for retention and student success services (Harvey and Luckman, 2014). Increasing the percentage of freshmen returning as sophomores is a crucial component of an effective student retention program (Bingham and Solverson, 2016).

The purpose of this study was to determine if university admissions data could be used to predict freshman to sophomore retention in the College of Agricultural, Food and Life Sciences (AFLS) at the University of Arkansas. Specific objectives were to:

1. Determine the sophomore retention status of first-time freshman admitted to AFLS between 1998 and 2015;
2. Determine if selected variables (admission year, high school GPA, composite ACT score, gender, major, Pell Grant eligibility, and first-generation college student status) were significantly ($p<0.05$) related to sophomore retention status of first-time freshmen admitted to AFLS between 1998 and 2015.

Methods

The population for this study included all AFLS students enrolling as new, full-time, first-semester freshmen (N=3,601) from 1998 to 2015. This specific population was studied because they are the students on which official institutional retention and graduation rates are based (DeAngelo et al., 2011).

After institutional IRB approval, the Office of Institutional Research (OIR) provided the researchers with admissions data for each student: year admitted, high school GPA, composite ACT score (major, categorized as human environmental sciences or agriculture), Pell grant eligibility (yes or no), and first-generation college student status (yes or no). The OIR also supplied matched data for each student's sophomore enrollment status (enrolled or not enrolled) and the current college for enrolled students. Sophomore enrollment data was used to classify each student into one of three mutually exclusive University of Arkansas retention categories: (a) not enrolled (Non-Returners), (b) enrolled in a different college (Non-AFLS Returners); and (c) enrolled in AFLS (AFLS-Returners). Complete data were available for 3,257 (90.4%) students. Because the data set consisted of official university records supplied by the OIR, the data was deemed valid and reliable.

Descriptive statistics, multinomial logistic regression, and marginal effects were used to analyze the data. According to Peng et al. (2002), *"logistic regression is well suited for describing and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictor variables"* (p. 4). Multinomial logistic regression consists of k -1 comparisons, where k is the number of categories, and each comparison is made in relation to a specified baseline category (Stokes et al., 2012). In this study, there were three retention categories (Non-Returners, Non-AFLS Returners, and AFLS-Returners) and, since our objective was to determine differences between AFLS-Returners and the other two groups, AFLS-Returners was specified as the baseline category. Thus, two comparisons (Non-Returners to AFLS-Returners and Non-AFLS Returners to AFLS-Returners) were made. For each model, logistic regression coefficients and odd ratios (ORs) compare Non-Returners or Non-AFLS Returners to AFLS-Returners. Marginal effects were also computed and analyzed to examine relationships across all three retention categories.

Multinomial logit models assume the independence of irrelevant alternatives (IIA); this assumption was tested using appropriate Hausman-McFadden (1984) tests. Of the three tests, one did not reject the IIA (at $p<0.05$) and the other two gave negative chi-square values. For negative values of the test statistics, Hausman and McFadden present an argument for not rejecting the null hypothesis although there is some dissent on the usefulness of this test statistic (Cheng and Long, 2007). Thus, based on the test results and the belief there were no close substitutes among the three alternatives, the researchers concluded use of multinomial logis-

tic regression was appropriate. Additional assumptions (Peng et al., 2002) related to independence of observations and sample size to predictor ratio were met.

Results

Between 1998 and 2015, 3,601 full-time, first time, first-semester freshmen enrolled in AFLS at the University of Arkansas. Nearly two-thirds (63.7%) of AFLS freshmen majored in agriculture while slightly over one-third (36.3%) majored in human environmental sciences. Females constituted most freshmen in both agriculture (52.4%) and in human environmental sciences (94.9%). Less than one-quarter of freshmen were first-generation college students (23.6%) or eligible for Pell Grants (21.4%). These freshmen had a mean high school grade point average of 3.54 (SD=0.43) and a mean composite ACT score of 24.54 (SD=3.60).

Correlation coefficients were calculated to examine the relationship between each of the demographic variables and year of college entry (1998 to 2015) to determine if students could be grouped across years for multinomial logistic regression. The results indicated significant but negligible to low (Davis, 1973) positive correlations between year and ACT score (r=0.05; r^2=0.0025), major (r_b=-0.07; r^2=0.0049), and status as a first-generation college student (r_b=0.15; r^2= 0.0225). The r^2 values indicated the variance explained by year ranged from 0.25% (for ACT score) to 2.25% (for first-generation status). Based on these results, students were grouped across years; however, year was retained as a potential predictor in subsequent analyses.

Overall, two-thirds (67.0%) of freshmen students were AFLS-Returners in the fall of the following academic year (AFLS-Returners). Students not returning to AFLS were almost equally divided between Non-Returners (16.2%) and Non-AFLS Returners (16.9%). Non-AFLS Returners switched to majors in arts and sciences (42.2%), education and health professions (27.0%), business (18.1%), engineering (9.1%), and architecture (3.6%).

Mean composite ACT scores were significantly (p<0.05) different for all three groups, being lowest for Non-Returners (M=23.28, SD=3.09), intermediate for AFLS-Returners (M=24.67, SD=3.56), and highest for Non-AFLS Returners (M=25.25, SD=3.93). Similarly, Non-Returners (M=3.33, SD=0.43) had a significantly lower (P<0.05) mean HSGPA than AFLS-Returners (M=3.57, SD=0.41) or Non-AFLS Returners (M=3.62, SD=0.42). Majorities of students within each retention group were female, majored in agriculture, and were not first-generation college students or eligible for Pell grants (Table 1).

Table 1. Frequencies and Percentages for Demographic Variables by Retention Status

	Retention Status					
	Non-Returner		Non-AFLS Returner		AFLS-Returner	
Variable	*f*	%	*f*	%	*f*	%
Gender						
Female	388	66.4	432	71.2	1622	67.3
Male	195	33.4	175	28.8	789	32.7
Major						
Human Environmental Sciences	201	35.5	271	44.6	832	34.6
Agriculture	382	65.5	336	55.4	1577	65.4
First-Generation						
No	333	64.5	466	82.9	1712	77.5
Yes	183	35.5	96	17.1	497	22.5
Pell-Eligible						
No	404	69.3	513	84.5	1913	79.3
Yes	179	30.7	94	15.5	498	20.7

Logistic Regression Models

The global test of the null hypothesis that no model coefficients were significantly different from zero was rejected, $\chi^2(12)=221.86$, $p<0.001$, pseudo-R^2=0.08. Although classification was not the primary objective of this study, the models were evaluated in terms of their accuracy and, while the models improved prediction relative to random assignment (e.g. 67.0% vs. 33.3%, respectively), they categorized virtually all (99.4%) students as AFLS-Returners. Frost (2013) asserted researchers can still *"draw important conclusions about how changes in the [individual] predictor variables are associated with changes in the response variable"* even when overall model classification is weak. Peng et al. (2012) and Silvestri et al. (2013) also supported this assertion.

Model One: Non-Returners vs. AFLS-Returners

The first model contrasted Non-Returners with AFLS-Returners. In interpreting the regression coefficients and odds ratios (*ORs*), positive coefficients and *ORs*>1.0 indicate an increase in the predictor is associated with an increased likelihood a student will be classified as a Non-Returner; negative coefficients and *ORs*<1.0 indicate an increase in the predictor is associated with a decreased relative likelihood a student will be classified as a Non-Returner.

Two variables significantly differentiated between Non-Returners and AFLS-Returners: HSGPA and First Generation college student status (Table 2). No other variables had a regression coefficient significantly (p<0.05) different from zero. Of particular interest, the regression coefficient (0.00) for Year was not statistically significant, indicating Year did not affect the likelihood of being a Non-Returner relative to an AFLS-Returner when holding all other predictors constant.

Table 2. Results of Multinomial Logistic Regression Modeling Non-Returners Compared to AFLS-Returners

		Odds Ratio with 95% *CI*		
	B (*SE*)[1]	Lower	Odds Ratio	Upper
Intercept	3.06 (0.47)***			
Year	0.00 (0.01)	0.98	1.01	1.02
ACT	-0.02 (0.02)	0.95	0.98	1.02
HSGPA	-1.23 (0.15)***	0.22	0.29	0.39
Gender[z]	-0.22 (0.12)	0.63	0.81	1.03
Major[y]	0.00 (0.12)	0.79	1.00	1.26
Pell Eligible[x]	0.15 (0.12)	0.91	1.17	1.49
First Generation[x]	0.50 (0.12)***	1.31	1.66	2.08

[1]NS, *, **, *** Nonsignificant or significant at P < 0.05, 0.01, or 0.001

[z]Coded 0 = Human Environmental Sciences and 1 = Agriculture

[y]Coded 0 = female and 1 = male

[x]Coded 0 = no and 1 = yes

The negative regression coefficient (-1.23) for HSGPA indicated students with higher HSGPAs were less likely to be Non-Returners in the sophomore year as compared to AFLS-Returners. The *OR* of 0.29 indicated that each one unit increase in HSGPA was associated with a 71% [(1-*OR*) x 100] decrease in the odds a student would be a Non-Returner relative to AFLS-Returners when all other variables in the model were held constant. Stated positively, a one-unit increase in HSGPA resulted in a 245% increase in the odds a student would be an AFLS-Returner as compared to a Non-Returner.

The positive regression coefficient (0.50) for First Generation indicated first generation college students were more likely to be Non-Returners for the sophomore year as compared to AFLS-Returners. The *OR* of 1.66 indicated being a first-generation college student was associated with a 66% increase in the odds of being a Non-Returner relative to AFLS-Returners, with all other predictors held constant.

Model Two: Non-AFLS Returners vs. AFLS-Returners

The second model contrasted Non-AFLS Returners with AFLS-Returners. Thus, positive coefficients and *ORs*>1.0, indicate an increase in the predictor was associated with an increased likelihood a student will be a Non-AFLS Returner; negative coefficients and *ORs*<1.0 indicate an increase in the predictor was associated with a decreased likelihood the student will be a Non-AFLS Returner.

Three variables significantly differentiated between Non-AFLS Returners and AFLS-Returners: composite ACT score, Major, and Pell grant eligibility. No other potential predictor, including Year, had a regression coefficient significantly ($p<0.05$) different from zero (Table 3).

The negative regression coefficients for Major (-0.50) and Pell (-0.33) indicated agriculture majors and Pell grant-eligible students were less likely to be Non-AFLS Returners (relative to AFLS-Returners) than were human environmental sciences majors and non-Pell-eligible students. The odds ratios indicated being an agriculture major was associated with a 39% decrease in the comparative odds a student would be a Non-AFLS Returner; being Pell-eligible was associated with a 28% decrease in the relative odds a student would be a Non-AFLS Returner.

The positive regression coefficient (0.05) for ACT indicated students with higher ACT scores were more likely to be Non-AFLS Returners as compared to AFLS-Returners. The OR of 1.06 indicated every one-unit increase in ACT score was associated with a 6% increase in the relative odds a student would be a Non-AFLS Returner.

Marginal Effects

To further explore the relationship between the predictors and freshman-to-sophomore retention outcomes, NLOGIT 5 (Econometric Software, Inc., 2012) was used to calculate marginal effects across all three retention outcomes for all predictors. A marginal effect is the change in probability of a specific retention outcome associated with a one-unit increase in the predictor, holding all other predictors at their mean values (Wulff, 2015). Thus, a marginal effect is the effect of a one-unit increase in a specific predictor on the average or typical subject. Across retention outcomes, the sum of the marginal effects for any predictor will be zero because students who are less likely to be represented in one retention outcome are equally more likely to be represented in one or both of the other retention outcomes.

When controlling for all other predictors, HSGPA had the largest overall marginal effect on retention status (Table 4). A one-unit increase in HSGPA significantly increased the probability of being an AFLS-Returner (0.116), decreased the probability of being a Non-Returner (-0.147), and (although not statistically significant) suggested an increased probability of being a Non-AFLS Returner (0.031). A one-unit increase in ACT score was associated with a statistically significant increase of 0.008 in the probability of being a Non-AFLS Returner and, although not statistically significant, a decrease in the probability of being an AFLS-Returner (-0.005) or a Non-Returner (-0.003). In the context of retention in AFLS, these results indicated a slight tendency to lose higher ACT score students and retain higher HSGPA students, with all other predictors held constant.

Table 3. Results of Multinomial Logistic Regression Modeling Non-AFLS Returners Compared to AFLS-Returners

		Odds Ratio with 95% *CI*		
	B (SE)[1]	Lower	Odds Ratio	Upper
Intercept	-2.23 (0.47)***			
Year	-0.15 (0.01)NS	0.97	0.99	1.00
ACT	0.05 (0.02)**	1.02	1.06	1.09
HSGPA	0.02 (0.15)NS	0.76	1.02	1.36
Gender[z]	-0.22 (0.12)NS	0.82	1.04	1.32
Major[y]	-0.50 (0.11)***	0.49	0.61	0.76
Pell Eligible[x]	-0.33 (0.14)*	0.55	0.72	0.95
First Generation[x]	-0.18 (0.13)NS	0.65	0.83	1.08

[1]NS, *, **, *** Nonsignificant or significant at P < 0.05, 0.01, or 0.001
[z]Coded 0 = Human Environmental Sciences and 1 = Agriculture
[y]Coded 0 = female and 1 = male
[x]Coded 0 = no and 1 = yes

Table 4. Marginal Effects on Retention Outcome of a One Unit Increase in Each Predictor, Holding all other Predictors at their Mean Values

	Retention Outcome					
	Non-Returner		Non-AFLS Returner		AFLS-Returner	
Predictor	Marginal effect	z[1]	Marginal effect	z[1]	Marginal effect	z[1]
Year	0.001	0.42NS	-0.002	-1.61NS	0.002	0.98NS
ACT	-0.003	-1.47NS	0.008	3.41***	-0.005	-1.63NS
HSGPA	-0.147	-8.83***	0.031	1.52NS	0.116	4.83***
Major[z]	0.011	0.79NS	-0.069	-4.49***	0.058	3.07**
Gender[y]	-0.026	-1.82NS	0.010	0.62NS	0.016	0.82NS
Pell Eligible[x]	0.026	1.77NS	-0.049	-2.54*	0.023	1.05NS
First-Generation[x]	0.065	4.71***	-0.037	-2.09*	-0.027	-1.34NS

Note. Marginal effects across each predictor may not sum to zero due to rounding.
[1]NS, *, **, *** Nonsignificant or significant at P < 0.05, 0.01, or 0.001
[z]Coded 0 = Human Environmental Sciences and 1 = Agriculture
[y]Coded 0 = female and 1 = male
[x]Coded 0 = no and 1 = yes

Being an agriculture major significantly decreased the probability of being a Non-AFLS Returner (-0.069), increased the probability of being an AFLS-Returner (0.058), and again, while not statistically significant, suggested an increased probability of being a Non-Returner (0.011). Pell-eligible students had a significantly lower probability of being a Non-AFLS Returner (-0.049) and higher (although not statistically significant) probabilities of being AFLS-Returners (0.023) or Non-Returners (0.026). Being a First-Generation college student significantly increased the probability of being a Non-Returner (0.65) and (although not statistically significant) decreased the probability of being either a Non-AFLS Returner (-0.037) or an AFLS-Returner (-0.027). Neither Year nor Gender had a significant marginal effect on the probability of any retention outcome for the average student.

The results based on the marginal effects were consistent with the logistic regression models. In both analyses, increases in HSGPA, being an agriculture major, and being Pell-eligible were associated with an increased probability of being an AFLS-Returner. Likewise, increases in ACT score and being a First-Generation college student were associated with a decreased probability of being an AFLS-Returner.

Summary

This study sought to determine if university admissions data could be used to predict freshman to sophomore retention in the College of Agricultural, Food and Life Sciences. Using data obtained from the University of Arkansas Office of Institutional Research it was determined that nearly two-thirds of the freshmen enrolled in AFLS between 1998 and 2015 majored in agriculture. Most freshmen in both agriculture and in human environmental sciences were female. However, this study noted no statistically significant association between gender or admission year as a predictor of retention, which does not support previous research by Broecke and Nicholls (2007), Leppel (2002), or Garton et al. (2002).

Most freshmen students returned to the University of Arkansas as AFLS majors in the fall of the following academic year (AFLS-Returners). Thirty-three percent of students were Non-Returners and were almost evenly divided between those not returning to the university and those returning to the university in non-AFLS majors. Model one of this study contrasted Non-Returners with AFLS-Returners. Two variables were identified as significantly differentiating between Non-Returners and AFLS-Returners: HSGPA and First Generation college student status. Students with higher HSGPAs were less likely to be Non-Returners in the sophomore year as compared to AFLS-Returners. The magnitude of this predictive factor was large - a one-unit increase in HSGPA resulted in a 245% increase in the relative odds a student would be an AFLS-Returner as compared to a Non-Returner. First generation college students were 66% more likely to be Non-Returners for the sophomore year as compared to AFLS-Returners. This is concerning because 23.6% of incoming AFLS freshman were first generation college students. Retention programs specifically targeted at First Generation college students are needed and should be a priority for AFLS.

Model two contrasted Non-AFLS Returners with AFLS-Returners. Three variables significantly differentiated between Non-AFLS Returners and AFLS-Returners: composite ACT score, Major, and Pell grant eligibility. Each one-point increase in ACT score was associated with a 6% increase in the relative likelihood a student would be a Non-AFLS Returners. Thus, students with higher ACT scores had an increased likelihood of switching to a non-AFLS major by their sophomore year. This research does not support Garton et al. (2002) who found both high school GPA and ACT scores to be the best predictors of student retention for college of agriculture students at the University of Missouri.

Agriculture majors were 39% less likely to be Non-AFLS Returners as compared to human environmental sciences majors. Although the specific reason students entering in agriculture majors tended to remain in AFLS could not be determined from the data, the authors posit this may be a result of these students' background experiences and self-identity with agriculture, farming, and rural life (Shoulders and Myers, 2011). Future research should explore this hypothesis, possibly through use of focus group techniques with agriculture majors.

Pell grant-eligible students were less likely (28% decrease) to be Non-AFLS Returners (relative to AFLS-Returners) than were non-Pell-eligible students. Previous research (Singell, 2004; Wei et al., 2009) indicated lower income students receiving Pell grants were more likely to persist than similar students not receiving Pell Grants; however, no studies suggested Pell-eligible students were less likely to change majors than non-Pell-eligible students. Thus, further research to better understand this finding is recommended.

When analyzing marginal effects across retention outcomes, HSGPA had the largest overall effect on retention status. The higher the HSGPA the more likely the student would be retained in AFLS for the sophomore year. Results indicated a tendency to lose higher ACT score students and retain higher HSGPA students. Therefore, recruitment strategies at University of Arkansas for the College of Agricultural, Food and Life Sciences may need to focus on higher HSGPA students versus higher ACT scores.

Additionally, agriculture majors were less likely to be Non-AFLS Returners and more likely to be AFLS-Returners. Additional research in this area should be conducted to determine if major selection and major commitment are related. Lastly, Pell-eligible students were more likely to return their second year as AFLS students, while First-Generation college students were less likely to return to the university as sophomores. Further study is needed to better understand the relationship between Pell-eligibility and AFLS retention. The finding of increased attrition of First-Generation students

is consistent with previous research (Mattern et al., 2015); given that nearly one-in-four AFLS freshmen is a First-Generation student, addressing this issue should be a priority for AFLS faculty, staff, and administrators.

Although recruitment is challenging for Colleges of Agricultural, Food and Life Sciences, retention remains the area of focus and need for many universities especially through developing and refining prediction models (Harvey and Luckman, 2014; Thammasiri et al., 2013). This comprehensive look at one college of agriculture is a first step in more deeply understanding retention issues and identifying areas of future focus. Additional research is needed to establish additional valid and reliable predictors of student success in colleges of agriculture.

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