



THE EDUCATIONAL ATTAINMENT CRISIS OF MALES

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ABSTRACT

A significant amount of scientific literature points to a growing concern that American males are not performing very well in traditional measures of educational outcomes. Specifically, the "boy crisis" as it has been labeled asserts that males lag far behind females in baccalaureate attainment. These assertions are countered by other researchers claiming that the perception of a "boy crisis" has been embraced by those seeking to advance various educational agendas. The analysis that follows addresses the issue without a specific agenda. The focus of this analysis is graduation outcomes at the associate degree level. This paper analyzes the graduation outcomes of males and females (n=16,532) at NIACC from 1996 to 2006. As graduation outcomes are influenced by more factors other than gender we will control for other important variables known to influence graduation, namely high school GPA, NIACC cumulative GPA and ethnicity. In addition to the independent effects of gender and ethnicity on graduation we will also test whether gender and ethnicity jointly interact to influence graduation outcomes.

IDENTIFICATION OF THE "BOY CRISIS" ISSUE

Tom Mortenson does an admirable job of identifying the educational attainment issue that this analysis addresses. Quoting Mortenson at length:

"Is there something wrong with this picture?"

- *Between 1970 and 2001 the number of bachelor's degrees awarded to men by Iowa's colleges and universities increased by 15.*
- *During this same 31 year period the number of bachelor's degrees awarded to women increased by 4,325.*

Expressed another way, of the total increase in bachelor's degrees between 1970 and 2001, 0.3 percent went to men and 99.7 percent went to women.

In 1970 men earned 56 percent of the bachelor's degrees in Iowa. By 2001 men earned 43 percent. And the gender imbalance shows up in most other degrees awarded by Iowa's colleges and universities as well:

- *42 percent of the associate degrees earned in 2001 went to men.*
- *46 percent of the master's degrees were earned by men.*
- *59 percent of the doctorates went to men." (Mortenson, 2004)*

However these assertions are countered by other scholars. For example, Sara Mead (2006) examined trends in achievement and education attainment and concludes that the recent surge of concern about boys' academic performance has been misguided. The perception of a "boy crisis" has been embraced, according to Mead, by those seeking to advance various educational agendas.

The analysis that follows addresses the issue without a specific agenda. The focus of this analysis is graduation outcomes at the associate degree level. This paper analyzes the graduation outcomes of males and females at NIACC from 1996 to 2006. As graduation outcomes are influenced by more factors other than gender we will control for other important variables known to influence graduation, namely high school GPA, NIACC cumulative GPA and ethnicity. In addition to the independent effects of gender and ethnicity on graduation we will also test whether gender and ethnicity jointly interact to influence graduation outcomes.

RESEARCH HYPOTHESES

The specific research hypotheses tested in the analysis are:

Table 1 Research Hypotheses

- 1 H_0 Graduation outcomes are not significantly different for males and females controlling for High School GPA, cumulative NIACC GPA and Ethnicity. In other words, Graduation is jointly independent of the predictors simultaneously.
 H_1 Graduation outcomes are significantly different for males and females controlling for High School GPA, cumulative NIACC GPA and Ethnicity. Graduation is not jointly independent of the predictors simultaneously.
- 2 H_0 Gender and Ethnicity do not jointly interact to explain Graduation outcomes after controlling for High School GPA and cumulative NIACC GPA.
 H_1 Gender and Ethnicity jointly interact to explain Graduation outcomes after controlling for High School GPA and cumulative NIACC GPA.

DATA

The data for this analysis was obtained from NIACC student records (n=16,532) from 1996 to 2006. Table 2 provides a cross tabulation of Gender by Degree Attainment.

***Table 2 Cross Tabulation:
Gender and Degree***

	Male	Female	Total
No Degree	5,723	5,370	11,093
Degree	2,246	3,193	5,439
Total	7,969	8,563	16,532

ANALYSIS

The first research hypothesis:

H_0 Graduation outcomes are significantly different for males and females controlling for High School GPA, cumulative NIACC GPA and Ethnicity

is tested through the following logistic regression (Eq. 1):

$$Eq.1: Prob(Graduation = 1 | (x)) = \lambda \left(\alpha + \beta_1 HS_GPA + \beta_2 GENDER + \beta_3 CUM_GPA + \beta_4 ETHNICITY \right)$$

where $\lambda(\cdot)$ is the logit function, $\exp(x)/(1 + \exp(x))$. The effects can be simply stated as the odds ratio.

The logistic regression produced the following parameter estimates (Table 3) and Odds Ratio Estimates (Table 4).

TABLE 3 LOGISTIC REGRESSION, EQ. 1						
Parameter	Estimate	Standard Error	Z	p-value	95 % Confidence Interval	
					Lower	Upper
CONSTANT	-3.400	0.129	-26.295	0.000	-3.653	-3.146
GENDER_Female	0.258	0.043	5.951	0.000	0.173	0.342
HS_GPA	0.162	0.039	4.122	0.000	0.085	0.238
CUM_GPA	0.835	0.024	34.327	0.000	0.788	0.883
ETHNICITY(White_Yes)	0.477	0.098	4.888	0.000	0.286	0.668
Likelihood Ratio = 2,299.03; df = 4; p = 0.000						
Naglekerke's R-square = 0.246						

TABLE 4 ODDS RATIOS, EQ. 1				
Parameter	Odds Ratio	Standard Error	95 % Confidence Interval	
			Lower	Upper
GENDER_Female	1.294	0.056	1.189	1.408
HS_GPA	1.175	0.046	1.088	1.269
CUM_GPA	2.306	0.056	2.198	2.418
ETHNICITY(White_Yes)	1.611	0.157	1.331	1.950

INTERPRETATION

MODEL INTERPRETATION. The logit model is statistically significant. The reported likelihood-ratio (LR) tests that Graduation is jointly independent of the predictors simultaneously; $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$. The LR test statistic of 2,299 is chi-squared with 4 degrees of freedom and a p-value of 0.000. This demonstrates strong evidence that at least one predictor has an effect on Graduation.

Nagelkerke's R-square is an attempt to imitate the interpretation of multiple OLS R-square based on the likelihood. Nagelkerke's R-square can vary from 0 to 1.

INTERPRETATION OF COEFFICIENTS. Table 3 indicates that all four predictors are significant ($p = 0.000$ for all predictors). Nevertheless, it is known that logistic coefficients may be found to be significant when the corresponding correlation is found to be not significant, and vice versa. To make certain statements about the significance of an independent variable, both the correlation and the logit should be significant. This additional test was completed, confirming $p = .000$ for the four predictors.

All coefficients are large relative to their standard errors and therefore appear to be important predictors of Graduation. However, the interpretation of the coefficients is quite different from ordinary least squares. The logit coefficient indicates how much the logit increases for a unit of change in the independent variable, but the probability of a 0 or 1 outcome is a nonlinear function of the logit. It is, therefore, more useful to turn to an evaluation of "odds ratios".

ODDS RATIO INTERPRETATION. The odds ratios in Table 4 provide a more intuitive and meaningful understanding for the impact of each predictor on Graduation. Table 4 reports odds ratio estimates for each of the four predictor variables as well as their standard errors and confidence intervals. As we are interested primarily in the effect of Gender we will begin with its impact.

GENDER. The odds ratio is a multiplicative factor by which the odds change when the independent variable increases by one unit, holding constant all other independent variables. The odds ratio for Gender 1.294¹.

Holding all other independent variables constant, the estimated odds that a female student graduates with a degree compared to a male student is 1.29 times (about 29% greater than) the odds of a male student graduating. We may say that in comparing female with male students, the odds that Graduation occurs increases by a factor of 29%, when all the other variables are controlled.

Statistical significance of Gender has already been established but "*confidence intervals are more informative than tests*" (Agresti, 2002:172). Table 4 provides confidence intervals for each predictor variable. At the 95% level of confidence degree attainment for female

¹ Given a logit coefficient, β_i , the odds ratio can be calculated $\exp(\beta_i)$. For example, the logit coefficient for Gender_Female equals 0.258. The odds ratio equals $\exp(0.258) = 1.294$.

students ranges from a minimum 1.19 times (19% greater than) to at most 1.41 times (41% greater than) the odds of a male student graduating, controlling for all other independent variables.

INTERPRETATION OF THE EFFECTS OF OTHER PREDICTORS ON GRADUATION

The odds ratio is a measure of effect size. The logit model posits three additional predictors that impact college graduation. In this section we will briefly summarize their important effects.

- **HIGH SCHOOL GPA.** The logit coefficient for “High School GPA” is 0.162. The estimated odds ratio between High School GPA and College Graduation equals $\exp(0.162) = 1.175$, the same value found in Table 4. Holding all other variables constant, a one unit increase in High School GPA has a multiplicative effect of 1.175 on the odds that Graduation occurs. A one unit increase in High School GPA, holding all other variables constant, improves the student’s odds for graduation by 17.5%. We may say that when High School GPA increases one unit, the odds that Graduation = 1 increases by a factor of 17%, when all other variables are controlled.
- **CUMULATIVE GPA.** The logit coefficient for “Cum_GPA” is 0.835. The estimated odds ratio between Cumulative GPA and College Graduation equals $\exp(0.835) = 2.306$, the same value found in Table 4. Holding all other variables constant, a one unit increase in Cum_GPA has a multiplicative effect of 2.306 on the odds that Graduation occurs. A one unit increase in Cum_GPA, holding all other variables constant, improves the student’s odds for graduation by 230%. At the 95% level of confidence degree attainment for a unit increase in Cum_GPA ranges from a minimum 220% to at most 242% effect on the odds of graduating.
- **Ethnicity.** The exponentiated difference between whites and minorities is an odds ratio comparing graduation outcomes. The difference between whites and minorities is a 0.477 logit coefficient. The estimated odds ratio between Ethnicity and College Graduation equals $\exp(0.477) = 1.611$, the same value found in Table 4. With all other predictors held constant, the estimated odds that a white student will graduate is $\exp(0.477) = 1.611$ (about 61% greater than) the odds of a minority student graduating.

OVERALL RANKING OF PREDICTORS ON GRADUATION

The odds ratios are measures of effect size and therefore are useful in assessing the relative effects of each independent variable on the dependent variable's odds. Table 5 ranks the variables of the analysis according to each variable's odds ratio effect on Graduation. As depicted in Table 5 Cumulative NIACC GPA has the most important effect on Graduation outcomes, followed in order with Ethnicity, Gender and High School GPA.

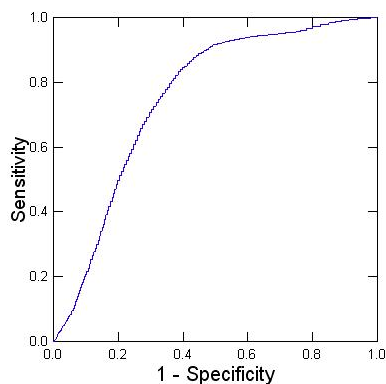
**TABLE 5 RANKING OF VARIABLES
BASED ON ODDS RATIOS**

Parameter	Rank	Odds Ratio
CUM_GPA	1	2.306
ETHNICITY(White_Yes)	2	1.611
GENDER_Female	3	1.294
HS_GPA	4	1.175

MODEL'S PREDICTIVE ABILITY

Given one of the primary purposes of logistic regression is to generate an equation that can reliably classify observations into one or two outcomes we can check the model's predictive ability through a graphical means, the ROC (Receiver Operating Characteristic) curve. The ROC curve is presented below.

Receiver Operating Characteristic Curve



The larger the area below the curve the better the model; that is, the better the predictions (Agresti, 2002). The area under the ROC curve

is 0.745, which is identical to another measure of predictive power, the *concordance index*, *c*. The concordance index estimates the probability that the predictions and outcomes are concordant. Values of 0.5 mean predictions are no better than random guessing.

DO GENDER AND ETHNICITY INTERACT TO EFFECT GRADUATION?

We have observed that both Gender and Ethnicity are significant independent predictors of Graduation. Females and whites have greater probabilities of graduation than males and minorities. In addition to their independent effects could it be that Gender and Ethnicity jointly interact to explain Graduation outcomes?

To test this hypothesis we add an interaction term, *Ethnicity*Gender*, to Eq. 1 to produce Eq. 2:

$$Eq. 2: Prob(Graduation = 1 | (x)) = \lambda \left(\begin{array}{l} \alpha + \beta_1 HS_GPA + \beta_2 GENDER + \\ \beta_3 CUM_GPA + \beta_4 ETHNICITY + \\ \beta_5 ETHNICITY * GENDER \end{array} \right)$$

The specific null hypotheses that we are testing at this stage of the analysis is that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$, where β_5 represents the interaction term (*Ethnicity*Gender*) that is of primary interest. Table 6 depicts the logistics regression for Eq. 2. Table 7 reports the associated odds ratios for Eq. 2.

TABLE 6 LOGISTIC REGRESSION, EQ. 2

Parameter	Estimate	Standard Error	Z	p-value	95 % Confidence Interval	
					Lower	Upper
CONSTANT	-3.545	0.151	-23.551	0.000	-3.840	-3.250
GENDER_Female	0.645	0.194	3.317	0.001	0.264	1.026
HS_GPA	0.158	0.039	4.023	0.000	0.081	0.235
CUM_GPA	0.835	0.024	34.291	0.000	0.787	0.882
ETHNICITY(White_Yes)	0.644	0.130	4.939	0.000	0.389	0.900
ETHNICITY*GENDER	-0.406	0.199	-2.044	0.041	-0.796	-0.017
Likelihood Ratio = 2,303.218; df = 5; p = 0.000						
Naglekerke's R-square = 0.246						

TABLE 7 ODDS RATIOS, Eq. 2				
Parameter	Odds Ratio	Standard Error	95 % Confidence Interval	
			Lower	Upper
GENDER_Female	1.906	0.371	1.302	2.791
HS_GPA	1.171	0.046	1.084	1.264
CUM_GPA	2.304	0.056	2.196	2.416
ETHNICITY(White_Yes)	1.905	0.248	1.475	2.459
ETHNICITY*GENDER	0.666	0.132	0.451	0.983

The logistics model, Eq. 2, is significant ($p = 0.000$) and a small increase in Naglekerke's R-square is noted.

The two models that we have developed can be assessed relative to each other. A likelihood ratio test is formally conducted by fitting two-nested models (the restricted and the unrestricted) and comparing the log likelihoods at convergence. Comparing the Eq. 2 model with the interaction term with the Eq. 1 model (without the interaction term) we can compute a chi-squared difference test as depicted in Table 8:

TABLE 8 LIKELIHOOD RATIO DIFFERENCE TEST						
Model 1 without Interaction Term		Model 2 with Interaction Term		Chi-square Difference		
<i>Likelihood Ratio – Eq. 1 Model 1</i>	<i>df - Model 1</i>	<i>Likelihood Ratio – Eq. 2 Model 2</i>	<i>df - Model 2</i>	<i>Difference</i>	<i>df</i>	<i>p</i>
2299.033	4	2303.218	5	4.185	1	0.041

With $p = 0.041$ the evidence for interaction is strong. Adding the interaction term, *Gender*Ethnicity*, to the model improves our understanding of graduation outcomes.

Adding the interaction term produces a significant logistics regression coefficient, β_5 , *Ethnicity*Gender*, with $p = 0.041$. All other predictor variables remain significant at $p = 0.000$. As such, we can say that not only do Gender and Ethnicity independently effect Graduation but they also jointly influence Graduation outcomes.

Does the more complex model with the interaction term change our interpretation of the relative effects of each predictor? Table 9 reports Model 1 and Model 2 odds ratios.

**TABLE 9 COMPARISON OF ODDS RATIOS:
MODEL 1 WITH MODEL 2**

	Model 1 without Interaction Term	Model 2 with Interaction Term
Parameter	Odds Ratio	Odds Ratio
CUM_GPA	2.306	2.304
ETHNICITY(White_Yes)	1.611	1.905
GENDER_Female	1.294	1.906
HS_GPA	1.175	1.171
ETHNICITY*GENDER	NA	0.666

It appears that the addition of the interaction term enhances the independent effects of both Gender and Ethnicity but leaves the effects of High School GPA and Cumulative GPA unchanged. The odds for Graduation for females is nearly double that for males, controlling for all other independent variables. Likewise, the odds for Graduation for whites is nearly double that for minorities, controlling for all other independent variables. White females increase their odds of graduation by an additional 67% in comparison to minority males.

CONCLUSION

Cumulative NIACC GPA has the most important effect on Graduation outcomes, followed in order with Ethnicity, Gender and High School GPA. Graduation outcomes are significantly different for males and females controlling for High School GPA, cumulative NIACC GPA and Ethnicity. Females and whites have greater probabilities of graduation than males and minorities. Gender is not the most important variable to influence Graduation outcomes but it is a significant predictor.

While Gender and Ethnicity are significant independent predictors of Graduation we also observe that Gender and Ethnicity jointly interact to explain Graduation outcomes. In the most complex model with the interaction of Gender and Ethnicity allowed to influence Graduation outcomes we identified the odds for Graduation for females as nearly double that for males, controlling for all other independent variables. Likewise, the odds for Graduation for whites is nearly double that for minorities, controlling for all other independent variables. Nevertheless, cumulative NIACC GPA and Ethnicity outweigh Gender effects.

In both models High School GPA had a significant but a much more trivial influence on degree attainment, controlling for all other variables.

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