Communities In Schools (CIS) of Durham

Graduation Coach Program:

Logistic Analysis of the Program Eligibility Criteria

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MASTER'S PROJECT TITLE

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I. PURPOSE OF STUDY

Communities In Schools (CIS) of Durham requested this master's project as part of its objective to use empirically tested programs to help reduce the dropout rate and prepare students for postsecondary success. The project investigates the extent to which the organization is using the appropriate eligibility criteria for admission into its graduation coach program. The study also provides information that could help the organization better target students for coaching services.

II. RESEARCH QUESTION

Is CIS of Durham's eligibility methodology appropriate for selecting students into its graduation coach program?

CIS of Durham uses an in-house simple averaging formula to select students for the graduation coach program (see "Program Eligibility Criteria"). The organization assumes that these students are in fact at risk of dropping out because current literature suggests that the formula's risk measures are good predictors of such behavior. However, the organization does not have hard evidence to support this assumption. This project attempts to fill this gap by calculating how well the at-risk indicators predict students dropping out of Durham public high schools.

III. CLIENT DESCRIPTION

A. CIS organizational framework and mission

CIS of Durham is part of Communities In Schools (CIS), a nonprofit federation with around 200 members. As one of the country's largest dropout prevention networks, CIS works with about 1.3 million students in 3,400 schools every year.[1] Every affiliate has the mission "to surround students with a community of support, empowering them to stay in school and achieve in life."[2] CIS members work with local schools "to identify at-risk students, evaluate school and student needs, and provide resources to tackle those needs."[3] Some of the services that CIS affiliates provide include counseling, mentoring, and afterschool programs. They also fundraise and collect, evaluate, and report data.[4]

B. Graduation coach program description

Through the graduation coach program, CIS of Durham places full-time mentors inside public schools to help at-risk students stay in school and graduate. The program includes college tours, mentoring, skills development, and internships (level II services) for a select number of students. The program also provides school-wide services, including basic needs resources and health screenings (level I services). All services are voluntary. The organization operates in Hillside High School, Southern High School, Neal Middle School, and the Durham Performance Learning Center (DPLC).[5] The organization provides services to over 20% of the student population[6] in the schools it serves except in the DPLC, which is a small, non-traditional high school with a

[1] ICF International, *Communities In Schools National Evaluation: Five Year Executive Summary*
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Bud Lavery, personal conversation with author, September 2012.
[6] Cassandra Davis, e-mail message to author, October 24, 2012.

coordinator serving all students.[7] The program began during the 2011-2012 academic year in all the schools except in the DPLC, which began three years earlier.[8]

C. Program eligibility criteria

CIS of Durham targets students for level II services that it has identified as being at risk of dropping out. The organization selects these individuals using an in-house formula loosely based on Robert Balfanz's research on early dropout indicators, including three main warning categories: attendance, academics, and behavior.[9] Figure 1 summarizes the risk measures.

Figure 1. CIS of Durham risk measures[10]

	Risk Level				
Risk Category	Outside	Low	Medium	High	Not Included
Attendance (Absences)	<15	15-18	19-22	23-25	>25
Academics (GPA)	>2.0	2.0-1.51	1.5-1.01	<1.01	N/A
Behavior (Suspensions)	0	1	2-3	4	>4

Any student who meets two out of the three risk categories qualifies for the program. To satisfy a particular category, the student must fall in the Low, Medium, or High risk levels. Students in the Outside and Not Included levels do not qualify because their risk priority is either too low or too high. Students with very high measures are not eligible for coaching services because the organization believes that these students require a more intensive treatment than what the program currently offers.[11]

[7] Cassandra Davis, personal conversation with author, October 19, 2012.
[8] Ibid.
[9] Ibid.
[10] Davis, "e-mail message."
[11] Davis, "personal conversation."

The organization uses a simple averaging procedure to calculate a student's risk ratio: Outside (0), Low (1), Medium (2) and High (3).[12] For example, if a student falls in the Medium attendance level, High academic level, and Outside behavior level, the student would have a ratio of:

2 (Medium) + 3 (High) + 0 (Outside) / 3 = 5/3 = 1.67

A 1.67 value indicates a risk priority level between Low and Medium.

CIS of Durham strictly enforced the "two-out-of-three" criterion and did not consider other factors for enrolling students in the graduation coach program for the 2011-2012 academic year.[13] Students who are selected and agree to participate receive level II services, while level I services are open to all students.[14]

IV. BACKGROUND

A. North Carolina's definition of a dropout

North Carolina defines a dropout as a student "who was enrolled in school at some time during the reporting year, who was not enrolled on day 20 of the current year, and has not graduated from high school or completed a state or district approved educational program." [15] Excluded from the dropout count are individuals who "transferred to a different public or private school, are home schooled, are temporary absent due to illness or suspension, or have left the country."[16]

[12] Davis, "e-mail message."
[13] Ibid.
[14] Lavery, "personal conversation."
[15] "Frequently Asked Questions," North Carolina Department of Public Instruction, accessed April 15, 2013, http://www.ncpublicschools.org/research/dropout/faq/.
[16] Ibid.

The North Carolina dropout rate is known as the "duplicate rate"[17] because individual students could be counted as dropouts more than once over multiple years (*e.g.*, A student leaves in year X, returns in year Y, but then drops out again later in year Y). The state would regard this example as two separate instances of dropping out; however, each incident would count only once per year.[18] The most recent report from the NC Department of Public Instruction shows that the state had a dropout rate of 3.01% (13,488 total high school students) in 2011-2012.[19] For Durham County, the rate was 3.55% (362 total individuals). [20]

A limitation of the dropout rate is that it does not provide any indication of how many students actually graduate from high school. Alternatively, the four-year graduation rate is a more appropriate measure for determining how many students earn a diploma because it accounts for individuals who eventually return to school after having dropped out in past years. To calculate the graduation rate, the state tracks how many freshmen graduated after four years. In 2011-2012, 80% of students graduated.[21]

B. Reasons for dropping out

Absenteeism was the most noted reason for dropping out among NC high school students.[22] However, researchers have identified many more factors that explain why students leave school, which often fall under two groups: external and internal factors.

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[17] *Report to the Joint Legislative Education Oversight Committee: Consolidated Data Report, 2011-2012* (Report No. 30 & 31) (Raleigh, NC: North Carolina Department of Public Instruction, 2013), 108, accessed April 15, 2013, http://www.ncpublicschools.org/docs/research/discipline/reports/consolidated/2011-12/consolidated-report.pdf.
[18] Ibid.
[19] Ibid, 109.
[20] Ibid, 121.
[21] Ann D. Helms, "Dropout Rates Continue to Fall in CMS, Across State," *The Charlotte Observer*, January 12, 2013, accessed April 15, 2013, http://www.charlotteobserver.com/2013/01/11/3780113/fewer-dropouts-in-charlotte-mecklenburg.html.
[22] "*Report to the Joint Legislative Education Oversight Committee,*" 109.

External factors are generally beyond the schools and educators' influences, such as low socioeconomic status, poor academic attainment, truancy, teen pregnancy, and lack of community resources to help at-risk students. Internal factors fall within the purview of schools, including, but not limited to, ineffective discipline and grading policies, negative educational environment, and failure to make the curriculum relevant or accessible to different learning styles.[23] Indeed, the list of reasons for dropping out is extensive. Yeboah, Faulkner, and Appiah-Danquah indicate, "When combined, both sets of factors lay the groundwork for understanding the problem of student dropout and how to address it."[24] That is, not one factor alone fully explains why students drop out.

Nevertheless, Balfanz, Herzog, and Mac Iver, through their work on dropout predictors, found that "two clear paths emerge"[25] even though there are different reasons why students become disengaged from school. One path is "rooted primarily in academic struggle and failure,"[26] while the other is "grounded in behavioral reaction to the school environment (misbehavior in school or a demonstrated aversion to attending school)."[27] The researchers concluded that, in accordance with previous studies, course grades, attendance, and misbehavior measures are robust indicators of dropping out.[28]

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[23] G. Sue Shannon and Pete Bylsma, *Promising Programs and Practices for Dropout Prevention* (Report No. 05-0049) (Olympia, WA: Assessment and Research, Office of Superintendent of Public Instruction, 2005), 2-3, accessed September 28, 2012. http://www.k12.wa.us/research/pubdocs/PromisingProgramsandPractices.PDF.

[24] Osei Agyeman Yeboah, Paula E. Faulkner, and Gloria Appiah-Danquah, "North Carolina High School Dropout Rates: An Econometric Analysis" (paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Orlando, Florida, February 6-9, 2010), 5, accessed October 11, 2012. http://ageconsearch.umn.edu/bitstream/56463/2/Yeboah_Faulkner_Appiah_Danquah_SAEA_2010%5B1%5D.pdf.

[25] Robert Balfanz, Liza Herzog, and Douglas J. Mac Iver, "Preventing Student Disengagement and Keeping Students on the Graduation Path in Urban Middle-Grades Schools: Early Identification and Effective Interventions," *Educational Psychologist* 42.4 (2007): 225, accessed April 13, 2013. http://web.jhu.edu/sebin/q/b/PreventingStudentDisengagement.pdf.

[26] Ibid.

[27] Ibid.

[28] Ibid, 233.

C. Costs of dropping out

Students who drop out of school present a difficult challenge for policymakers. Dropouts have lower lifetime earnings, lower employment rates, and higher incarceration rates.[29] The average person without a high school degree makes $10,386 less annually than the average high school graduate. For individuals with a college degree, the difference jumps to $36,424 in additional income. In August 2012, the unemployment rate for individuals without a high school diploma was about 4% higher than the national average. Furthermore, young dropouts (ages 16-24) were 63 times more likely than college graduates to be incarcerated. Dropouts cost taxpayers $292,000 over their lifetime in greater public expenditures and lost taxes. [30]

D. Effectiveness of dropout prevention programs

School districts across the country have implemented an array of programs and policies to help students stay in school. The studies below demonstrate the effectiveness of some of these interventions, particularly of graduation coach programs.

Lacefield, Zeller, and Van Kannel-Ray indicate that one of the main purposes of graduation coach programs is to provide at-risk students with structural support to "deliberately facilitate [their] academic success."[31] Graduation coaches attempt to foster a positive learning environment to help at-risk individuals address some of the challenges they face in school, such as attaining academic proficiency and navigating

[29] Alex J. Bowers, Ryan Sprott, and Sherry A. Taff, "Do We Know Who Will Drop Out?: A Review of the Predictors of Dropping out of High School: Precision, Sensitivity, and Specificity," *The High School Journal* 96, no. 2 (2013): 77, http://muse.jhu.edu/.
[30] Jason M. Breslow, "By the Numbers: Dropping Out of High School." *PBS*, September 21 2012, accessed April 16, 2013, http://www.pbs.org/wgbh/pages/frontline/education/dropout-nation/by-the-numbers-dropping-out-of-high-school/.
[31] Warren E. Lacefield, Pamela J. Zeller, and Nancy Van Kannel-Ray, "Graduation Coaching in High-Need Urban, High Schools" (paper presented at the 2010 Annual Conference of the American Educational Research Association, Denver, Colorado, May 1, 2010), 2, accessed April 16, 2013, http://www.eric.ed.gov/PDFS/ED509289.pdf.

through communal violence, drug abuse, adolescent pregnancy, and other challenges.[32]

The GEAR Up Learning Centers at Western Michigan University developed the GEAR Up graduation coach program with the purpose to help at-risk students succeed academically. Coaches, students, parents, and teachers work together to create an intervention plan that addresses students' individual needs. The program was implemented in both urban and rural high schools in Michigan. A 2012 longitudinal, causal-comparative study of the GEAR UP program found that graduation coaching has the potential to advance "student retention, success, and perseverance to graduation"[33] in a rural school setting. The study compared two groups of high school students with similar educational experiences and demographic characteristics. One group received personalized coaching services, while the other group did not.[34] A similar study two years prior by some of the same researchers also found promising results in improving students' academic achievement and retention in high-need urban high schools.[35]

In another study, researchers from ICF International found that the CIS of Central Texas graduation coach program had a significant positive impact on attendance rates, GPA, and credit completion after students received one year of program services. Some of the services provided included anger and behavior management, health awareness, public assistance, parent conferences, family counseling, after-school enrichment programs, tutoring, and college preparation. The researchers also found positive results after two years of treatment, but the findings were not significant—perhaps because the

[32] Ibid.
[33] Pamela J. Zeller et al., "Graduation Coaching in a Rural District School" (paper presented at the 2012 Annual Conference of the American Educational Research Association, Vancouver, BC, Canada, April 17, 2012), 1, accessed September 28, 2012, http://www.rockyview.ab.ca/assets/whats-new/2012-lacefield-graduation-coaching.
[34] Ibid, 9.
[35] Lacefield, Zeller, and Van Kannel-Ray, "Graduation Coaching in High-Need Urban, High Schools," 1-2.

students received less services in year two than in year one. The study was conducted as a randomized control trial (RCT) of at-risk eligible students from six Austin Independent School District high schools.[36]

ICF International conducted two more RCT studies for the graduation coach programs of the Jacksonville and Wichita CIS affiliates. The researchers concluded that the Jacksonville program for middle school students demonstrated "positive promising trends."[37] Specifically, the program services were "pushing students toward better [academic] outcomes and [were] adding an additional buffer for these students (keeping them slightly above their comparisons even if not statistically significant)."[38] The researchers suggested that the lack of significance was perhaps due to the school-wide availability of CIS and non-CIS services.[39]

The Wichita program had mixed findings. The study showed negative results in high school student outcomes after one year of intervention.[40] However, after two years, the researchers found "promising positive trends for the student measures of personal responsibility, student attendance, GPA, credit completion, and Kansas State mathematics assessments."[41] The researchers suggested that midyear changes in CIS of Wichita staff during the first year, including the replacement and resignation of the

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[36] ICF International, *Communities in Schools National Evaluation Volume 5: Randomized Controlled Trial Study Austin, Texas* (Arlington, VA: Communities in Schools, 2010), i-3, accessed November 28, 2012, http://www.communitiesinschools.org/media/uploads/attachments/CIS_RCT_Study_Austin_Volume_5_final.pdf.

[37] ICF International, *Communities in Schools National Evaluation Volume 4: Randomized Controlled Trial Study Jacksonville, Florida* (Arlington, VA: Communities in Schools, 2010), vii, accessed April 15, 2013, http://www.communitiesinschools.org/media/uploads/attachments/CIS_RCT_Study_Jacksonville_Volume_4.pdf.

[38] Ibid.

[39] Ibid.

[40] ICF International, *Communities in Schools National Evaluation Volume 6: Randomized Controlled Trial Study Wichita, Kansas* (Arlington, VA: Communities in Schools, 2010), iii, accessed April 15, 2013, http://www.communitiesinschools.org/media/uploads/attachments/CIS_RCT_Study_Wichita_Volume_6.pdf.

[41] Ibid.

Service Coordinator and Executive Director respectively, might have influenced the results. Also, the students received more services during the second year.[42]

The benefits of the graduation coach model extend beyond middle and high school students. In a randomized experiment of the InsideTrack program, Bettinger and Baker found that undergraduate students from public and private universities who received coaching services had higher retention and graduation rates. Some of the services offered included guidance on goal setting and time management and study skills development.[43] Indeed, the InsideTrack study reinforces the notion that despite the many factors influencing students dropping out of school, coaching programs have the potential to help students of all ages stay in school and graduate.

V. STUDY DESIGN

A. Descriptive analysis

After I obtained permission from Duke University's Institutional Review Board (IRB), the North Carolina Education Research Data Center (NCERDC) supplied school- and student-level data for the project. I divided the information into three groups: all students in the sample, students eligible for the program, and dropouts. For each group, I provided descriptive statistics on the percent of students in each risk level (Outside, Low, Medium, High, and Not Included) for the three indicators (absences, suspensions, and GPA). I also described the ethnic and gender composition of each student group.

[42] Ibid.
[43] Eric P. Bettinger and Rachel Baker, "The Effects of Student Coaching in College: An Evaluation of a Randomized Experiment in Student Mentoring" (working paper 16881, National Bureau of Economic Research, 2011), 1-21, accessed April 16, 2013, http://www.nber.org/papers/w16881.pdf.

B. Analytical method

I used logistic regression (logit) to determine the predictive power of the graduation coach program eligibility indicators. The logit is appropriate for describing the relationship between a binary independent variable and the explanatory variables. The model estimates the probability that an event will occur.[44] Specifically, I modeled the relationship between dropping out of school (outcome) and the CIS at-risk categories. I controlled for gender, ethnicity, and free/reduced price lunch. All the explanatory variables measured characteristics for students in the 10th grade.

i. Description of outcome and explanatory variables

Outcome variable: The dependent variable indicated if the state of North Carolina classified the student as a dropout (see "Background"). I counted students only once if they had dropped out at any point over the course of their junior or senior years. If a student met the definition, I gave the individual a value of 1. If not, the student received a value of 0 (see Figure 2).

Figure 2. Description of outcome variable

Outcome	Description	Symbol
Dropout status	Binary variable indicating if the student dropped out of school during junior or senior year: No (0), Yes (1)	DROPOUTX

Independent variables: I selected the explanatory variables based on the data available through the NCERDC and according to what the current literature says are some of the factors associated with dropping out (see "Background").

[44] Oscar Torres-Reyna, "Getting Started in Logit and Ordered Logit Regression," Princeton University, http://dss.princeton.edu/training/Logit.pdf.

Absences, suspensions, and GPA were the primary predictors of interest since CIS of Durham uses them to determine eligibility for the graduation coach program. I divided each indicator into categories that correspond to how the organization labels at-risk students (see Figure 1). Figures 3-5 summarize each variable.

The absences predictor (ABSX_i) was comprised of five binary sub-variables that indicated if a student fell in a particular risk level. For example, if a student missed 16 school days in the 10th grade, then the individual fell in the Low risk level (ABSX_2). I gave the student a value of 1 for ABSX_2 and a value of 0 for ABSX_1, ABSX_3, ABSX_4, and ASBX_5. Throughout the study, I used ABSX_i as short notation for the five risk levels.

Figure 3. Description of absences

Absences (ABSX_i)		
Risk level (ranges)	**Description**	**Symbol**
Outside (<15)	All risk levels were binary and indicated if the student fell in a particular absences range: No (0), Yes (1)	ABSX_1
Low (15-18)		ABSX_2
Medium (19-22)		ABSX_3
High (23-25)		ABSX_4
Not Included (>25)		ABSX_5

As with absences, suspensions (SUSPX_i) consisted of five risk levels. For example, the Outside category indicated that the student did not receive any suspensions in 10th grade. I used SUSPX_i for short notation, where i= 1-5.

Figure 4. Description of suspensions

Suspensions (SUSPX_i)		
Risk level (ranges)	**Description**	**Symbol**
Outside (0)	All risk levels were binary and indicated if the student fell in a particular suspensions range: No (0), Yes (1)	SUSPX_1
Low (1)		SUSPX_2
Medium (2-3)		SUSPX_3
High (4)		SUSPX_4
Not Included (>4)		SUSPX_5

GPA (GPAX_i) only had four risk levels, but still followed the same notation pattern as absences and suspensions. For example, a student with a GPA under 1.01 fell in the High risk level (GPAX_4= 1). I used the symbol GPAX_i for this predictor, where i= 1-4.

Figure 5. Description of GPA

GPA (GPAX_i)		
Risk level (ranges)	**Description**	**Symbol**
Outside (>2.0)	All risk levels were binary and indicated if the student fell in a particular academic range: No (0), Yes (1)	GPAX_1
Low (2.0-1.51)		GPAX_2
Medium (1.5-1.01)		GPAX_3
High (<1.01)		GPAX_4

Ethnicity (Eth_i) referred to a student's ethnic background (Black, Hispanic, Other, or White). For example, I gave a Hispanic student a value of 1 for Eth_3 and a 0 for the other ethnicity binaries.

Free/reduced price lunch was a binary control indicating if the student received the lunch benefit (yes= 1, no= 0). Gender noted if the student was male (yes= 1, no= 0).

Figure 6. Description of ethnicity, gender, and free/reduced price lunch

Variable (risk level)	Description	Symbol
Ethnicity (Eth_i)		
White	All sub-variables were binary and indicated the ethnicity of the student	Eth_1
Black		Eth_2
Hispanic		Eth_3
Other		Eth_4
Gender (GNDR)		
Gender	Binary variable indicating if the student was female (0) or male (1)	GNDR
Free/Reduced Price Lunch (FRLNCH)		
Free/Reduced Price Lunch	Binary variable indicating if the student received free or reduced price lunch: No (0), Yes (1)	FRLNCH

ii. Description of logistic analysis

I used logistic regression to estimate the relationship between dropping out and the six explanatory variables. The model was formulated as $\ln(p/1-p)= \alpha + \beta_n X_n$, where ln is the natural log, p is the probability that DROPOUTX=1, α is a constant, and β_n are the regression coefficients for the predictors X_n, where n= 1-6.

I used STATA to estimate the regression coefficients and relied on the odds ratio (OR) method to report the results. STATA has a built-in function that transforms the coefficients into odds ratios. A ratio equal to 1 suggests no effect on the odds of dropping out, a ratio greater than 1 indicates that a particular variable is associated with higher odds, and a ratio less than 1 suggests lower odds.[45] For example, an odds ratio of 2 for free/reduced price lunch would suggest that the odds of dropping out are 2 times greater for students who received this benefit relative to students who did not.

Selecting a logit model requires researchers to make tough choices about what should and should not be in the regression equation. We often use a combination of empirical evidence and theory to support the model's fitness. I ran multiple logits that combined different predictors to see which model fit the data best. I used the Hosmer-Lemeshow goodness of fit (Lfit) method to test the null hypothesis that a particular logit fit the data at an acceptable level. The Lfit follows a chi-squared distribution with n-2 degrees of freedom.[46] I used the logit with the strongest evidence of fit for the study.

[45] Magdalena Szumilas, "Explaining Odds Ratios," *Journal of the Canadian Academy of Child and Adolescent Psychiatry* 19.3 (2010): 227–229, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2938757/.
[46] Viv Bewick, Liz Cheek, and Jonathan Ball, "Statistics Review 14: Logistic Regression," *Critical Care* 9.1 (2005): 112–118, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1065119/.

C. Data handling procedures

I narrowed the analysis to the Durham Public Schools (DPS) since CIS of Durham is primarily interested in students from this district. Also, focusing on the DPS allowed me to eliminate district-level differences that could impact the dependent variable, including location setting (urban, suburban, or rural), student population size, and budget. For example, some districts may have more resources to prevent students from dropping out, increasing the probability that a student will stay in school.

The district has five traditional four-year high schools (Hillside, Jordan, Northern, Riverside, and Southern) and various specialized schools.[47] I focused the analysis on the five regular schools to account for school-level differences, such as school size, curriculum, and grade levels (9^{th}-12^{th}), which could also influence the probability of dropping out.

From the traditional schools, I selected students who were in the 10^{th} grade in the 2009-2010 academic year and determined if they had dropped out by the end of their senior year. For this step, I linked three different databases. The first database (masterbuild) contained a list of all the 10^{th} graders in the five schools in 2009-2010, while the second and third contained all the students who dropped out at any point in 2010-2011 or in 2011-2012. The NCERDC indicated that only a small percentage of students in the dropout files could not be matched with the masterbuild.[48]

The NCERDC also gave me access to information on students' behavior, academic performance, attendance, and demographics. Below I explain some of the assumptions I made about the data before I proceeded with the analysis.

[47] "Our Schools," Durham Public Schools, accessed April 15, 2013, http://www.dpsnc.net/pages/Durham_Public_Schools/Our_Schools.
[48] Kara Bonneau, personal conversation with author, March 2013.

Suspensions: The NCERDC provided records on every legally reportable suspension.[49] If a student did not appear in the database, then the individual either had no suspensions or the information was missing. The NCERDC staff indicated that the student was most likely not suspended since the organization was unable to match suspension information on only a small percentage of student records.[50]

GPA: The NCERDC does not keep GPA records for grades 9-11; instead, it gave me transcript information for individual students. I calculated the students' unweighted GPAs using all the courses I found in the database for each student's freshman and sophomore years. I used the DPS grading scale to do the calculations (see Figure 7).

Figure 7. DPS grading scale[51]

Grade	Grade Scale	GPA Value
A	93-100	4
B	85-92	3
C	77-84	2
D	70-75	1
F	0-69	0

As is the case in many datasets, not all student records had complete information. I assumed that the information was missing completely at random (MCAR). MCAR says that the "probability that an observation is missing is unrelated to the value of [the observation] or to the value of any other variables."[52] For example, missing information in SUSPX_i would not be considered MCAR if schools with higher

[49] To see more detailed information on legally reportable suspensions and the collection of discipline data go to: http://dpi.state.nc.us/research/discipline/.
[50] Kara Bonneau, e-mail message to author, March 29, 2013.
[51] "3200-Grading System," Durham Public Schools, accessed April 15, 2013, http://www.dpsnc.net/pages/Durham_Public_Schools/District/About_DPS/District_Policies/Series_3000_-_Curriculum_and_I/3200
[52] David C. Howell, "Treatment of Missing Data--Part 1," The University of Vermont, last modified December 9, 2012, accessed April 9, 2013, http://www.uvm.edu/~dhowell/StatPages/More_Stuff/Missing_Data/Missing.html.

suspension rates were less likely to report the number of suspensions for each student. However, since schools are legally obligated to report such instances,[53] the missing data was perhaps most likely the result of random collection and reporting errors.

I used listwise deletion to remove records with any missing information. In particular, ABSX_i and GPAX_i had missing data. Using the listwise technique sometimes requires that researchers drop a large number of observations from the analysis, reducing the power of the model. However, the regression estimates remain unbiased if the data is assumed to be MCAR.[54] In this study, the procedure reduced the dataset by 113 observations to 1,845, which is a relatively small drop.

VI. FINDINGS

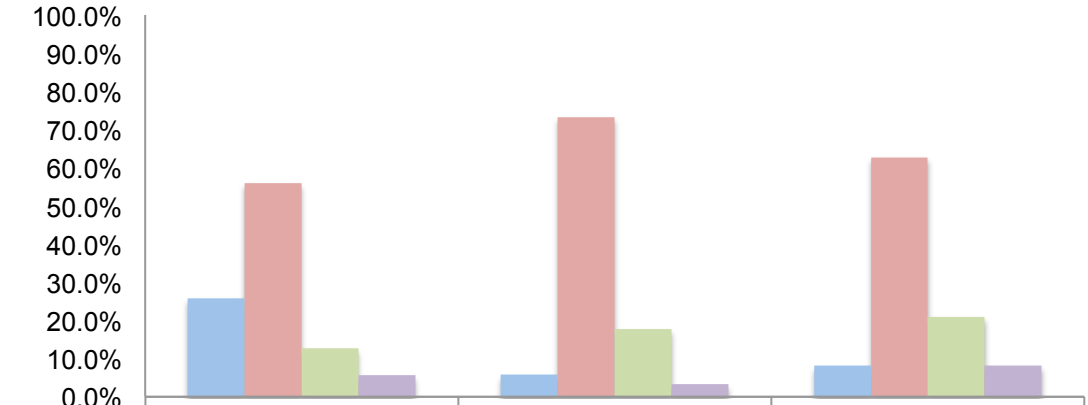
A. Summary statistics

Of the 1,845 10th graders from the five traditional DPS schools in 2009-2010, 110 students dropped out by the end of their senior year. Under the CIS of Durham eligibility criteria, 276 students qualified for the program. Below I describe the three groups of students (total sample, eligible, and dropouts) by ethnicity, gender, absences, suspensions, and GPA.

[53] "Collection Process," North Carolina Department of Public Instruction, accessed April 15, 2013, http://dpi.state.nc.us/research/discipline/collection/.
[54] Howell, "Treatment of Missing Data--Part I."

i. Ethnicity

Figure 8. Composition of students by ethnicity



	10th Graders (n=1845)	Eligible (n=276)	Dropouts (n=110)
White	25.8%	5.8%	8.2%
Black	55.9%	73.2%	62.7%
Hispanic	12.7%	17.8%	20.9%
Other	5.6%	3.3%	8.2%

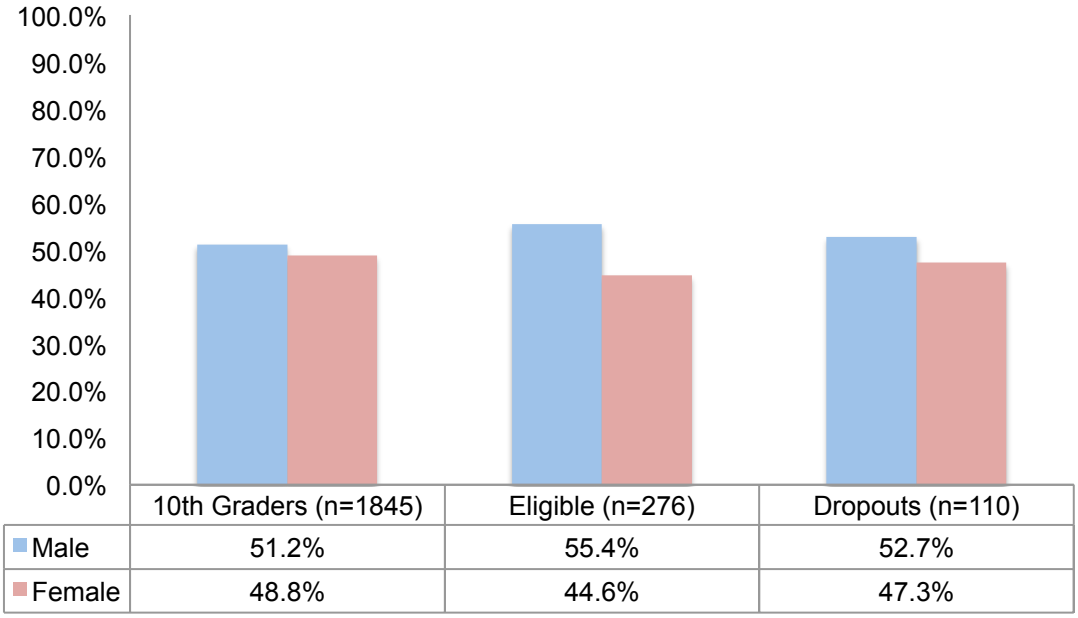
Over half of the students in the sample were black (55.9%), 25.8% were white, 12.7% were Hispanic, and 5.6% were classified as "other."

Eligible students for the graduation coach program tended to be disproportionally black and Hispanic. While just over half of 10th graders were black, roughly three quarters (73.2%) of eligible students belonged to this group. Hispanic students comprised the second largest group of eligible students (17.8%), a 5.1% difference from their proportion in the sample.

Dropouts also tended to be minority students. Sixty-two percent of dropouts were black, while 20.9% were Hispanic students. Noteworthy, white students comprised only 7% of dropouts even though they accounted for about one quarter of 10th graders.

ii. Gender

Figure 9. Composition of students by gender

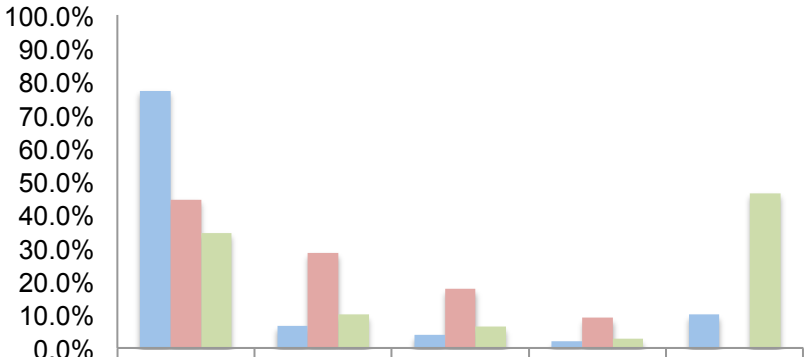


	10th Graders (n=1845)	Eligible (n=276)	Dropouts (n=110)
Male	51.2%	55.4%	52.7%
Female	48.8%	44.6%	47.3%

The split between male and female students was fairly even in the sample at 51% and 49% respectively. The difference between male (52.7%) and female dropouts (47.3%) was about 6%. The largest discrepancy was among eligible male and female students. About 11% more males qualified for the program than females.

iii. Absences

Figure 10. Composition of students by absences risk level



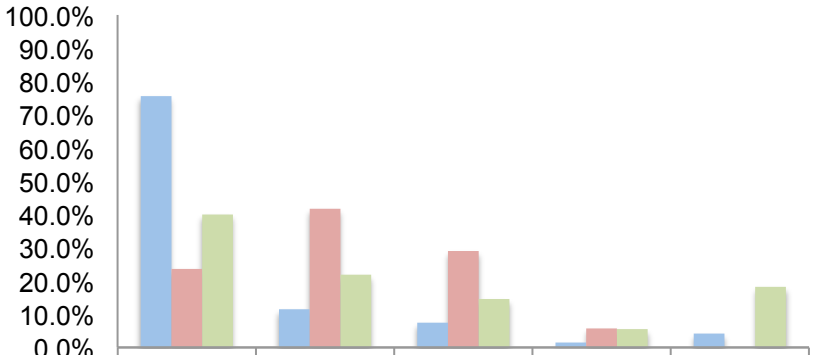
	Outside (<15)	Low (15-18)	Med (19-22)	High (23-25)	Not Inc. (>25)
10th Graders (n=1845)	77.2%	6.7%	4.0%	2.0%	10.1%
Eligible (n=276)	44.6%	28.6%	17.8%	9.1%	0
Dropouts (n=110)	34.5%	10.0%	6.4%	2.7%	46.4%

Absences risk levels

Nearly eight out of ten students (77.2%) had fewer than 15 absences (Outside risk level) in 2009-2010. Eligible students were absent more frequently than the larger sample, but the difference was seemingly small (73.2% of eligible students missed fewer than 18 days). On the other hand, nearly half (46.4%) of dropouts missed school more than 25 days per year (Not Included risk level). The three middle risk levels for the absences variable had relatively few observations (<13% combined), suggesting that CIS of Durham may need to shorten the ranges of the Outside and Not Included risk levels while expanding the Low, Medium, and High levels' ranges.

iv. Suspensions

Figure 11. Composition of students by suspensions risk level



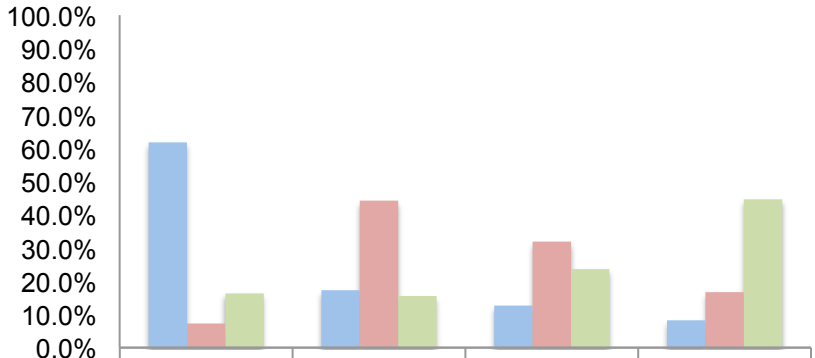
	Outside (0)	Low (1)	Med (2-3)	High (4)	Not Inc. (>4)
10th Graders (n=1845)	75.5%	11.5%	7.4%	1.4%	4.2%
Eligible (n=276)	23.6%	41.7%	29.0%	5.8%	0
Dropouts (n=110)	40.0%	21.8%	14.5%	5.5%	18.2%

Suspensions risk levels

Most 10th graders (75.5%) had no suspensions (Outside risk level). By comparison, most eligible students (76.5%) had at least 1 suspension (Low-High risk levels). For dropouts, as the risk levels increased, the percent of students in each risk group decreased, except for the Not Included level. The data showed a substantial jump in the number of dropouts with 5 or more suspensions. As in absences, this sharp rise suggests that CIS of Durham may need to modify the ranges of the suspensions risk levels to better measure their effect on dropping out.

v. GPA

Figure 12. Composition of students by GPA risk level



	Outside (>2.0)	Low (2.0-1.51)	Med (1.5-1.01)	High (<1.01)
10th Graders (n=1845)	61.7%	17.3%	12.7%	8.2%
Eligible (n=276)	7.2%	44.2%	31.9%	16.7%
Dropouts (n=110)	16.4%	15.5%	23.6%	44.5%

GPA risk levels

GPA showed important differences between the larger sample, eligible students, and dropouts. While most 10th graders (61.7%) had a C average grade or better (Outside risk level), most eligible students (76.1%) had a GPA between 1.01 and 2.0 (Low-Medium risk levels). Just under half of dropouts (44.5%) had a GPA below 1.0, indicating that dropouts tend to perform worse academically than their peers.

B. Results from logistic regression

The purpose of the logit was to model the relationship between dropping out of school and the CIS of Durham at-risk predictors while controlling for gender, ethnicity, and free/reduced price lunch.

i. Selecting the logit

I ran an Lfit test on several models with different combinations of predictors to see which regression fit the data at an acceptable level. To pass the Lfit test, the resulting statistic had to be greater than the critical value of 0.05. The table below indicates that model #4 provides the strongest evidence in support of a favorable Lfit test (p-value= 0.227). This logit excluded ETHNICITY and FRLNCH. Noteworthy, these two variables were not significant in all the models that did include them. That is, ethnicity and receiving free/reduced price lunch did not appear to have a significant effect on the odds of dropping out.

Figure 13. Goodness of fit test for possible logits

Equation (logit)	Lfit (p-value)
Three Variables	
1. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i$	0.011
Four Variables	
2. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \varepsilon_i ETHNICITY$	0.029
3. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \eta FRLNCH$	0.046
4. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \gamma GNDR$	0.227
Five Variables	
5. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \varepsilon_i ETHNICITY + \eta FRLNCH$	0.005
6. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \varepsilon_i ETHNICITY + \gamma GNDR$	0.078
7. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \gamma GNDR + \eta FRLNCH$	0.041
Six Variables	
8. logit(DROPOUTX)= $\alpha + \beta_i GPAX\_i + \delta_i ABSX\_i + \lambda_i SUSPX\_i + \varepsilon_i ETHNICITY + \gamma GNDR + \eta FRLNCH$	0.002

ii. Results for model #4

I analyzed model #4 and used STATA to produce the table below. The p-values with an asterisk indicate that the corresponding predictor was significant (<0.05).

Figure 14. Logit output for model #4

Equation (logit)	Predictor	Odds Ratio	Stnd. Errors	P-value
logit(DROPOUTX)= $\alpha + \beta_i$GPAX_i + δ_iABSX_i + λ_iSUSPX_i + γGNDR	GPAX_i			0.000*
	GPAX_2	2.630	0.952	0.008*
	GPAX_3	4.608	1.590	0.000*
	GPAX_4	13.189	4.835	0.000*
	ABSX_i			0.001*
	ABSX_2	2.414	0.937	0.023*
	ABSX_3	1.716	0.752	0.218
	ABSX_4	1.323	0.827	0.654
	ABSX_5	4.122	1.370	0.000*
	SUSPX_i			0.177
	SUSPX_2	2.084	0.659	0.020*
	SUSPX_3	1.005	0.347	0.989
	SUSPX_4	1.378	0.912	0.628
	SUSPX_5	1.343	0.554	0.475
	GNDR	0.759	0.175	0.232

The table shows that only GPAX_i (p-value= 0.000) and ABSX_i (p-value= 0.001) had an overall significant influence on dropping out. However, despite the favorable Lfit test, these results may not be entirely reliable since I did not account for the presence of multicollinearity. This problem arises when some of the independent variables are correlated with each other. A common side effect of multicollinearity includes large standard errors for the collinear variables, undermining the significance of the predictors and making the odds ratios hard to interpret.[55] The correlations matrix below indicates a sizeable degree of correlation between GPA, suspensions, and

[55] Xiao Chen et al., *Logistic Regression with Stata* (Los Angeles: UCLA Institute for Digital Research and Education), chapter 3, section 3, accessed April 15, 2013, http://www.ats.ucla.edu/stat/stata/webbooks/logistic/chapter3/statalog3.htm.

absences. This relationship is not surprising since, for example, suspensions lead to students missing class, which could lead to poor academic performance.

Figure 15. Correlation matrix for predictors

Correlation	GNDR	ABSX_i	SUSPX_i	GPAX_i
GNDR	1.0000			
ABSX_i	-0.0259	1.0000		
SUSPX_i	0.1212	0.4780	1.0000	
GPAX_i	0.1311	0.4673	0.5119	1.0000

iii. Dropping predictors from model #4

Some of the options for addressing multicollinearity involve dropping, combining, or transforming variables.[56] Perhaps the simplest method is to remove collinear variables. Regardless of the technique, changing any of the CIS of Durham predictors to obtain a better logit suggests that the selection criteria for the program may need to be revised since the objective of the organization is to identify those students with the greatest likelihood of leaving school. I examined one of the methods below.

When I removed GPA from the logit, both absences (p-value= 0.000) and suspensions (p-value= 0.004) were significant overall. When I dropped absences, GPA was significant overall (p-value= 0.000), but not suspensions (p-value= 0.076). Dropping suspensions leads to both GPA (p-value= 0.000) and absences (p-value= 0.000) being significant. These omissions suggest that to some degree, the three predictors are measuring the same effect and that one of them, most likely GPA, is capturing most of the influence on the dependent variable.

[56] Ibid.

Figure 16. P-values when dropping predictors from model #4

Drop GPAX_i	
Predictor	**P-value**
ABSX_i	0.000*
SUSPX_i	0.004*
GNDR	0.873

Drop ABSX_i	
Predictor	**P-value**
GPAX_i	0.000*
SUSPX_i	0.076
GNDR	0.054

Drop SUSPX_i	
Predictor	**P-value**
GPAX_i	0.000*
ABSX_i	0.000*
GNDR	0.268

GPAX_i has been significant in every logit thus far, indicating that it should remain in the model. The next option is to remove either ABSX_i or SUSPX_i since both of these variables appear to be redundant in measuring the effect on dropping out. To choose between the two predictors, I conducted an Lfit test on two logits (one without absences and the other without suspensions). Both models produced favorable Lfit statistics above the critical value of 0.05.

Figure 17. Lfit test for logits with dropped predictors

Action	Equation (logit)	Lfit
Dropped ABSX_i	logit(DROPOUTX)= $\alpha + \beta_i$GPAX_i + λ_iSUSPX_i + γGNDR	0.546
Dropped SUSPX_i	logit(DROPOUTX)= $\alpha + \beta_i$GPAX_i + δiABSX_i + γGNDR	0.896

However, as noted in Figure 16, the logit without absences yielded an insignificant SUSPX_i variable (p-value= 0.076). If we choose this model, only GPAX_i remains as the sole significant predictor. As a result, I kept ABSX_i and dropped SUSPX_i from the logit. For CIS of Durham, this finding suggests that the organization should consider dropping suspensions from the eligibility criteria.

iv. Results for logit without suspensions

Having refined the logit, I examined gender, GPA, and absences in greater detail. STATA produced the following results:

Figure 18. Output for logit without suspensions

Equation (logit)	Predictor	Odds Ratio	Stnd. Errors	P-value
logit(DROPOUTX)= α + β_iGPAX_i + δ_iABSX_i + γGNDR	GPAX_i			0.000*
	GPAX_2	2.838	1.004	0.003*
	GPAX_3	5.097	1.721	0.000*
	GPAX_4	14.884	5.393	0.000*
	ABSX_i			0.000*
	ABSX_2	2.401	0.901	0.020*
	ABSX_3	1.884	0.805	0.138
	ABSX_4	1.553	0.919	0.457
	ABSX_5	4.165	1.240	0.000*
	GNDR	0.781	0.175	0.268

Even though more males dropped out than females (see Figure 9), gender was not significant when controlling for academic performance and absences (p-value= 0.268). The data suggests that dropping out is gender-blind for this sample of students.

As expected, higher GPA risk levels are associated with higher odds of dropping out. For example, the odds of leaving school are almost 15 times greater for a student with a GPA below 1.0 (High risk) relative to a student with a GPA above 2.0 (Outside risk). These results indicate that the GPA risk levels are properly denominated (the higher the risk level, the greater the odds of dropping out) and that CIS of Durham should continue to use GPA as an eligibility criterion.

On the other hand, the absences indicator produced an odd result. While ABSX_i was significant overall (p-value= 0.000), some of the risk levels were not. Figure 19 shows the p-values for significance tests I performed on the variable's risk ranges. The null hypotheses stated that there was no difference in odds ratios between risk levels.

For example, the data suggested no difference in odds ratios between the High and Outside risk groups (p-value= 0.457). Said differently, the odds of dropping out were not significantly greater for students with 23-25 absences relative to students with 0-15 absences. The same conclusion applied to students with 19-22 absences compared to their peers with fewer than 15 missed days (p-value= 0.138). These findings suggest that CIS of Durham should consider readjusting the ranges of the risk levels for the absences predictor.

Figure 19. Difference testing for absences at-risk levels

ABSX_i	Outside	Low	Medium	High	Not Included
Outside	-				
Low	0.020*	-			
Medium	0.138	0.039*	-		
High	0.457	0.061	0.283	-	
Not Included	0.000*	0.000*	0.000*	0.000*	-

v. Results for logit with readjusted absences risk levels

The significance tests in the previous section provide some guidance on how the organization could readjust the risk levels for the absences predictor. The Not Included category was significantly different from the other four, suggesting that the rearranging should occur below this level. I divided the ranges of the Outside, Low, Medium, and High levels into approximately equal numbers of missed days to see how the model changed. Figure 20 shows the new ranges.

Figure 20. Readjusted absences risk levels

	Risk Level				
Predictor	Outside	Low	Medium	High	Not Included
Absences	0-6	7-12	13-19	20-25	>25

Under the readjustment, a student with 15 absences, for example, would now fall in the Medium risk category instead of the Outside level. In the dataset, the individual would now have a value of 1 for ABSR_3 and a 0 for the other four binaries. I called the modified absences variable ASBR_i, where i= 1-5.

Figure 21. Description of readjusted absences variable

Readjusted Absences (ABSR_i)		
Risk level (new range)	**Description**	**Symbol**
Outside (0-6)	All risk levels were binary and indicated if the student fell in a particular readjusted absences range: No (0), Yes (1)	ABSR_1
Low (7-12)		ABSR _2
Medium (13-19)		ABSR _3
High (20-25)		ABSR _4
Not Included (>25)		ABSR _5

The new absences predictor produced the following results:

Figure 22. Logit output for model with recoded absences

Equation (logit)	Predictor	Odds Ratio	Stnd. Errors	P-value
logit(DROPOUTX)= α + β_iGPAX_i + δ_iABSR_i + γGNDR	GPAX_i			0.000*
	GPAX_2	2.451	0.865	0.011*
	GPAX_3	4.271	1.422	0.000*
	GPAX_4	11.730	4.277	0.000*
	ABSX_i			0.000*
	ABSR_2	2.383	0.919	0.024*
	ABSR_3	3.758	1.463	0.001*
	ABSR_4	3.864	1.745	0.003*
	ABSR_5	7.927	3.152	0.000*
	GNDR	0.788	0.177	0.291

Gender remained insignificant (p-value= 0.291). GPA overall continued to have a significant effect on dropping out (p-value= 0.000) and the odds of doing so increased with higher risk levels.

Absences was significant overall (p-value= 0.000), indicating that the readjusted predictor should be a part of the program eligibility criteria. Also, the results show that

the risk levels are better denominated—higher absences risk levels are associated with significantly higher odds of dropping out. For example, the odds of leaving school are almost 4 times greater for a student with 20-25 absences (High risk) relative to a student with 0-6 missed days (Outside risk). Given these findings, CIS of Durham should consider adopting the ranges I used for readjusting the absences predictor (see Figure 20).

VII. POLICY RECOMMENDATION

The logistic analysis indicated that CIS of Durham could enhance the program's admission criteria. The changes I proposed in the "Findings" section aim to help the organization better target students for the program. Foremost, I suggest eliminating the "two-out-of-three" rule because the data demonstrated that absences and suspensions have a noticeably redundant effect on dropping out. Of these two predictors, I recommend removing suspensions since the variable remained insignificant overall even when dropping absences from the logit. If the organization adopts this option, graduation coaches will select students on just GPA and absences.

The data also showed that the GPA risk levels were correctly denominated for this predictor—the odds of dropping out increase as GPA decreases. I propose no changes to this variable. On the other hand, the ranges of the absences risk levels could be improved. In particular, the Medium and High risk levels did not have a significant effect on the odds of dropping out compared to some of the other levels. I recommend changing the ranges as follows:

Figure 24. Proposed changes for absences risk levels

	Risk Level				
Absences	Outside	Low	Medium	High	Not Included
New ranges	0-6	7-12	13-19	20-25	>25
CIS of Durham ranges	<15	15-18	19-22	23-25	>25

Using my proposed changes, graduation coaches could choose among at-risk students by giving priority to those who fall in the riskier levels. For example, a student with a GPA below 1.0 and 20 absences would have priority over a student with a GPA below 1.0 and 10 absences. CIS of Durham could still use a simple averaging formula to measure students' risk ratios. In the example above, the first student would have a risk average of 3 (GPA high risk) + 3 (absences high risk)= 6/2= 3, while the second student's average would be 3 (GPA high risk) + 1 (absences low risk)= 4/2= 2.

The new system would indicate that the odds of dropping out are greater for students with increasingly poor academic performance and attendance. Excluding the Not Included absences risk level, if CIS of Durham focuses on students with risk averages between 2 and 3 (medium to high risk), about 9% of 10th graders would qualify for the program. If the organization also includes students with a low risk average, then 35% of students would be eligible. These two percentages represent a difference of -6% and +20% respectively from the current eligibility level of 15% using the "two-out-of-three" rule.

VIII. LIMITATIONS

The results of this project cannot be generalized beyond the design of the study and its assumptions. Given data limitations, I made the assumption that the logit was well specified. However, the literature suggests that other factors besides absenteeism and poor academic performance are significant indicators of dropping out. For example, the level of parental involvement could be a significant factor; however, I did not have access to this information. CIS of Durham should treat the study's recommendations as a general rule of thumb. Graduation coaches should make every effort to assess the individual needs of students.

Furthermore, I was unable to obtain suspension, GPA, and attendance data from CIS of Durham on the students currently participating in the graduation coach program. The organization should collect this data for future studies. Access to this information would have allowed me to enhance this project by analyzing how closely the composition of current participants resembles the larger sample of students who qualify for the services.

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