Massachusetts

Early Warning Indicator System (EWIS)

*Technical Descriptions of Risk Model Development:*

Middle and High School Age Groupings

(Grades 7-12)

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Massachusetts Department of Elementary and Secondary Education &   
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# Overview

The Massachusetts Department of Elementary and Secondary Education (Department) created the grades 1-12 Early Warning Indicator System (EWIS) in response to district interest in the Early Warning Indicator Index (EWII) that the Department previously created for rising grade 9 students. Districts shared that the EWII data were helpful, but also requested early indicator data at earlier grade levels and throughout high school. The new EWIS builds on the strengths and lessons learned from the EWII to provide early indicator data for grades 1-12.

The Department worked with American Institutes for Research (AIR) to develop the new risk models for the EWIS. AIR has extensive experience with developing early warning systems and supporting their use at the state and local levels. AIR conducted an extensive literature review of the research on indicators for early warning systems. AIR then identified and tested possible indicators for the risk models based on those recognized in the research and data that are collected and available from the Department’s data system. Because of limitations in the availability of data for children from birth through pre-kindergarten, the students from kindergarten through twelfth grade were the focus of EWIS statistical model testing. Massachusetts’ longitudinal data system allowed estimated probabilities of being at risk on the predefined outcome measures for students based on previous school years. The model for each grade level was tested and determined separately. While there are some common indicators across age groupings and grade levels, the models do vary by grade level. A team from ESE worked closely with AIR in determining the recommended models for each grade level and an agency-wide EWIs advisory group reviewed research findings and discussed key decisions.

To develop the early elementary risk model, we used a multilevel modeling framework to control for the clustering of students within schools and obtain correct robust standard errors (Raudenbush & Bryk, 2002). To develop the late elementary, middle and high school risk models, we used a logistic regression modeling framework[[1]](#footnote-1). The model allows users to identify students who are at risk of missing key educational benchmarks (a.k.a. outcome variables) within the first through twelfth grade educational trajectory. The outcome variables by which students risk is tested took into consideration the degree to which the outcome variable is age and developmentally appropriate (e.g., achieving a score that is proficient or higher on the third grade English Language Arts in Massachusetts Comprehensive Assessment System).

The following research questions guided the development of the EWIS statistical model that helps identify risk levels for individual students: *What are the indicators (or combination of indicators) that predict whether are at risk of missing key educational benchmarks in Massachusetts that are above and beyond student demographic characteristics, based on predefined student clusters and appropriate outcome variables?*

Identification of at-risk students through the risk model developed for each age group served as the foundation of the EWIS, which aims to support practitioners in schools and districts to identify children/students who may be at risk. With this relevant and timely information, teachers, educators, and program staff will be able to intervene early and provide students with the targeted support. The EWIS identification of at-risk students is designed to provide an end of year indicator, which is cumulative for an academic year of school and identifies students with a risk designation to inform supports in the next school year.

## Age Groups and Outcome Measures

Students are grouped by grade levels and related academic goals were identified that are developmentally appropriate, based on available state data, and meaningful to and actionable for adult educators who work with the students in each grade grouping. Each academic goal is relevant to the specific age grouping, and also ultimately connected with the last academic goal in the model: high school graduation.

For example, the early elementary age group encompasses grades one through three, and assesses risk based on the academic goal of achieving a score of proficient or higher on the third grade ELA MCAS, a proxy for reading by the end of third grade, a developmentally appropriate benchmark for children in the early grades. Reading by the end of the third grade is also associated with the final academic goal in the model of high school graduation. Exhibit 1.1 provides an overview of the age groups and outcome variables for the risk model.

**Exhibit 1.1 Overview of Massachusetts EWIS age groups and outcome variables**

|  |  |  |
| --- | --- | --- |
| Age Groups | Grade Levels | Academic Goals  *(expected student outcomes for each age group)* |
| Early Elementary | Grades 1-3 | Proficient or advanced on 3rd grade ELA MCAS |
| Late Elementary | Grades 4-6 | Proficient or advanced on 6th grade ELA and Mathematics MCAS |
| Middle Grades | Grades 7-9 | Passing grades on all 9th grade courses |
| High  School | Grades 10-12 | High school graduation |

## Risk Indicators

The risk indicators tested in the Massachusetts’ risk model are comprised of indicators that have been identified in research, as well as data elements that are collected and available from the ESE data system. Many of the indicators are dependent on the availability of ESE student level data over a number of years.[[2]](#footnote-2) Since 2002 ESE has collected extensive individual student information through Student Information Management System (SIMS). SIMS data provided information on student demographics, enrollment, attendance, and suspensions, with a unique statewide identification code (a State-Assigned Student Identifier, SASID). Recently, ESE has begun collecting course taking and course performance data at the middle and high school levels. Although these data have not been collected for enough years (at least six years) to use statewide data for the development of the EWIS model, a sample of eight urban and suburban districts provided longitudinal course taking and course performance data so that these variables could be included into the middle and high school models. In turn, these data were linked to SIMS data. By linking SIMS data across years, this study was able to identify whether a student moved school during a school year and whether a student was retained in grade.

## 

## Risk Levels

There are three risk levels in the EWIS: low, moderate, and high risk. The risk levels relate to a student’s predicted likelihood for reaching a key academic goal if the student remains on the path they are currently on (absent interventions). In other words, the risk level indicates whether the student is currently “on track” to reach the upcoming academic goal. A student that is “low risk” is predicted to be likely to meet the academic goal. The risk levels are determined using data from the previous school year. The risk levels are determined on an individual student basis and are *not* based on a student’s relative likelihood for reaching an academic goal when compared with other students. As a result there are no set amounts of students in each risk level. For example, it is possible to have all students in a school in the low risk category.

**Exhibit 1.2 Massachusetts Early Warning Indicator System : Risk Levels**

|  |  |
| --- | --- |
|  | *Indicates that, based on data from last school year, the student is…* |
| Low risk | likely to reach the upcoming academic goal |
| Moderate risk | moderately at risk for not reaching the upcoming academic goal |
| High risk | at risk for not reaching the upcoming academic goal |

## Validating the Risk Models

Once the models were finalized, the risk model for each grade level was validated using a second cohort of student data (e.g., the 2008-09 third grade cohort to the 2009-10). The intent of this step is to examine the extent to which the finalized risk model, developed using the original cohort data, correctly identifies at risk students in the validation cohort in terms of those who met or exceeded the risk thresholds (low, moderate, high) of the predefined outcome measure.

The following procedure was followed to make this determination. First, regression coefficients were compared in terms of the direction of the estimated coefficient and its statistical significance in each individual variable by running the same model for the validation cohort data. Second, the accuracy of prediction was examined by applying the equation of the already developed EWIS risk model to the validation cohort data. Comparisons were made between the original cohort data and validation data to see whether the validation cohort showed the same level of prediction accuracy in the proportion of students who were classified as at risk and actually did not met or exceeded the risk threshold of the outcome variable.

## Final Risk Model

Exhibit 1.3 provides an overview of the indicators that are included in the models based on the testing and validation of the Massachusetts Early Warning Indicator System Risk Model for the early elementary, late elementary, middle school and high school age groups. The list of indicators is representative of some of those that were tested. In grades where the tested indicators are marked with an “x,” these indicators were found to add to the predictive probability of the model and are included in the model.

**Exhibit 1.3 Overview of the final Massachusetts Early Warning Indicator System models, by grade level**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Grade Level** | | | | | | | | | | | |
| **Age Group** | **Early Elementary** | | | **Late Elementary** | | | **Middle School** | | | **High School** | | |
| **Outcome Variable** | Proficient or Advanced on 3rd Grade ELA MCAS | | | Proficient or Advanced on 6th Grade ELA & Math MCAS | | | Pass all Grade 9 Courses | | | Graduate from HS in 4 years | | |
| **Indicators Included in Risk Model** | **1st** | **2nd** | **3rd** | **4th** | **5th** | **6th** | **7th** | **8th** | **9th** | **10th** | **11th** | **12th** |
| Attendance rate | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| School move  (in single year) | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |  |  |  |
| Number of in-school and out-of-school suspensions | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| MEPA Levels |  |  |  | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |
| ELA MCAS |  |  |  | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |
| Math MCAS |  |  |  | **x** | **x** | **x** | **x** | **x** | **x** | **x**\* |  |  |
| Retained |  | **x** | **x** | **x** | **x** | **x** | **x** |  | **x** | **x** |  |  |
| Low income | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |
| Special education  level of need | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| ELL status | **x** | **x** | **x** |  |  |  |  |  |  |  |  |  |
| Gender | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Urban residence | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Overage for grade | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  | **x** | **x** | **x** |
| School wide Title I | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Targeted Title I | **x** | **x** | **x** | **x** | **x** | **x** |  |  |  |  |  |  |
| Math course performance |  |  |  |  |  |  | **x** | **x** |  | **x** | **x** | **x** |
| ELA course performance |  |  |  |  |  |  | **x** |  | **x** | **x** | **x** | **x** |
| Science course performance |  |  |  |  |  |  | **x** |  | **x** | **x** | **x** | **x** |
| Social studies course performance |  |  |  |  |  |  |  | **x** |  | **x** | **x** | **x** |
| Non-core course performance |  |  |  |  |  |  | **x** | **x** | **x** | **x** | **x** | **x** |

Notes:

* In grades where the tested indicators are marked with an “x,” these indicators were found to add to the predictive probability of the model, typically at an alpha level of .10. We chose a less conservative critical alpha level, because overidentification was preferred over underidentification in order to reduce the risk of excluding students in need of support or intervention, and because the risk models of middle and high school age groups were based on district data instead of state-wide data. Additional consideration was also given to consistency of models, especially in the middle and high school age groupings when dealing with smaller sample sizes.
* Mobility was initially tested for middle and high school age groupings, but due to use of course performance data from a subset of districts, the variable was excluded. A large proportion of students who moved schools within the school year ended up lacking sufficient course performance information and/or not being part of the outcome sample (by ninth grade they were not enrolled in a school that was taking part in the data pilot).
* Due to small sample in individual MEPA levels in middle and high school, final model aggregates MEPA levels beginner to intermediate as a single indicator, leaving transiting to regular classes and non-MEPA as 0 for this variable. The benefit of this strategy is that this indicator fits in the EWIS models with the current MEPA levels having 5 categories. Thus, the binary indicator of MEPA levels was used for many of the EWIS models.
* The 10th grade model (built using data from 9th grade students) uses the MCAS score from 8th grade since 9th grade is not a tested MCAS grade. ELA MCAS results were not available for use in 10th grade model due to available years of data. 8th grade ELA MCAS was first administered in 2006 and so could not be used in developing the model since data was not available for validation. This variable will be tested for inclusion in future years.
* Retention variable was not used as an indicator in high school age grouping, because the variable was directly related to the outcome benchmark in high schools, i.e., on-time graduation.

Special education variable has 4 categories based on levels of need of special education: 1) Low- less than 2 hours, 2) Low - 2 or more hours, 3) Moderate, and 4) High. Each indicators denoting individual level of need were tested. However, due to data limitations with small sample sizes in middle and high school age grouping, the directions and magnitudes of the coefficients appeared inappropriate. Thus, we ended up using a binary indicator covering low to high levels of need (2 hours or more) in the middle and high school age group. We plan retesting individual indicators representing each level of need in special education when state-wide data are available.

* Overage for early elementary, late elementary and middle school is defined as one year older than the expected age for the grade level. For the high school, students two or more years older than expected grade level are considered overage.

Due to data limitations with smaller sample size with middle and high school age groupings, Targeted Title I was miniminally represented, so only school wide Title I is in middle and high school age grouping models.

* Variables indicating whether a student did not enroll in or miss a certain subject (‘flagged’) were not tested in middle schools, because the numbers of students in falling in this category were too small (less than 2%).

# Middle School Age Group (Seventh through Ninth Grade)

The Middle School Age Group encompasses seventh through ninth grade, using data from students during their sixth, seventh and eighth grade years. Within the age group indicators of risk were tested at each grade level based on the outcome variable of passing all 9th grade courses.

## Potential Indicators

In the Middle School Age Group, the indicators tested included behavioral, demographic, MEPA levels, MCAS proficiency, other variables and course outcomes[[3]](#footnote-3). Behavioral indicators are mutable and considered manifestations of student behavior (e.g., attendance, suspensions). Demographic indicators are tied to who the child is, and are not necessarily based on a student’s behavior (although some of these, such as low income household, may change over time). Other individual student indicators are focused on characteristics related to the community in which the student resides and the type of services the student receives The middle school analysis brings in prior skill assessments, using MEPA levels and MCAS proficiency[[4]](#footnote-4) in mathematics and English language arts, as well as student course performance, which results in substantial improvement of prediction accuracy. *Exhibit Middle School.1* provides a summary of the indicators that were tested in the middle school grades.[[5]](#footnote-5)

**Exhibit Middle School.1. Indicator Definitions, by Type**

| **Type** | | **Indicator** | **Definition** | | | | | | **Corresponding**  **Data Source** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Outcome Variable** | | |  | |  | | | |  |
|  | | Passed all 9th Grade Courses | Binary variable: 1= Received a 60 or greater numeric or D- or greater letter grade in all classes grade 9; 0=Received less than 60 or less than D- letter grade in one or more classes grade 9;  Indicates students who passed all classes grade 9 | | | | | | District Data from pilot sites |
| **Behavioral Variable** | | | |  | |  | | |  |
|  | | Attendance | Continuous variable: Attendance rate, end of year- number of days in attendance over the number of days in membership | | | | | | SIMS DOE045  SIMS DOE046 |
|  | | Suspension | Continuous variable: Suspensions, end of year - number of days in school suspension plus number of days out of school suspension | | | | | | SIMS DOE017  SIMS DOE018 |
|  | | Retention[[6]](#footnote-6) | Binary variable: Based on whether child is listed as same grade status in between two consecutive years 1=Retained; 0=Not retained | | | | | | SIMS DOE016 |
|  | | Mobility**[[7]](#footnote-7)** | Binary variable: 1=School code changes from beginning of school year to end of school year; 0= School code is the same at beginning and end of school year | | | | | | SIMS 8 digit school identifier |
| **Demographic variable** | | | |  | |  | | |  |
|  | | Gender | Binary variable: 1=Female; 0=Male | | | | | | SIMS DOE009 |
|  | | Low income household – Free lunch | Binary variable: 1=Free lunch eligible; 0= not eligible | | | | | | SIMS DOE019 |
|  | | Low income household – Reduced price lunch | Binary variable: 1=Reduced lunch recipient; 0= Not eligible for reduced price lunch | | | | | | SIMS DOE019 |
|  | | ELL program | Binary variable: 1= sheltered English Immersion (SEI) or 2-way bilingual or other;  0 = opt out, no program | | | | | | SIMS DOE014 |
|  | | Overage | Binary variable: 1=Age of child is equal to or greater than one year than expected grade level age as of September 1 in a given calendar year; 0= Age of child is less than one year older than expected grade level age (e.g. a student is 13 or older as of September 1st as they enter 7th grade) | | | | | | SIMS DOE006 |
|  | | Immigration Status | Binary variable: 1= Student is an immigrant under the federal definition; 0=Student is not an immigrant | | | | | | SIMS DOE022 |
|  | | Urban residence | Binary variable: 1=Student lives in an urban area[[8]](#footnote-8); 0= Student does not live in one of the specified urban areas | | | | | | SIMS DOE014 |
|  | | Special Education – Level of Need | Special Education[[9]](#footnote-9): Level of need Low to High (2 hours or more) is equal to 1; otherwise 0. | | | | | | SIMS DOE038 |
| **Other Individual Student Variable** | | | | | | |  |  |  |
|  | | Title I participation | Binary variables:   * School -wide Title I[[10]](#footnote-10), Binary variable: 1= School-wide Title I; 0= Not school-wide Title I | | | | | | SIMS DOE020 |
| **MEPA Levels** | | | | |  | | | |  |
|  | Massachusetts English Proficiency Assessment (MEPA) | | Binary variable:   * Beginner level to Intermediate level is equal to 1; otherwise 0.[[11]](#footnote-11) | | | | | | MEPA Spring data variable name:  pl |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **MCAS Proficiency Levels** | | | | |
|  | MCAS Proficiency levels in Math and English (as available) | | Multiple indicators   * Math[[12]](#footnote-12)   + Dummy variable: Warning is equal to 1; otherwise 0.   + Dummy variable: Needs improvement is equal to 1; otherwise 0.   + Dummy variable: Proficient is equal to 1; otherwise 0. * English[[13]](#footnote-13)   + Dummy variable: Warning is equal to 1; otherwise 0.   + Dummy variable: Needs improvement is equal to 1; otherwise 0.   Dummy variable: Proficient is equal to 1; otherwise 0. | MCAS data for cohort in analysis  name:  EPERF2 MPERF2 |
| **Course Outcomes** | | | | |
|  | | Course Information | District Course information[[14]](#footnote-14)  Failed: received a numeric mark less than 60 or a letter grade of F or a categorical grade of Failing.   * Failed any Math   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any ELA   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any Science   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any Social Studies   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any non-core courses   + Dummy variable: Failed equal to 1; otherwise 0. | Districts data from Pilot sites |

## Analysis Methods and Strategies

To identify the model that most accurately predicts risk of not passing all courses in grade 9, we conducted multiple analyses. A separate analysis was conducted in each grade to predict a risk level for students as they entered the next year: seventh grade (using students’ grade 6 data), eighth grade (using students’ grade 7 data), and ninth grade (using students’ grade 8 data).

For risk model development for the middle school age group, we focused on 2009-10 grade 9 cohort , and linked the cohort with SIMS data in 2005-06 through 2007-08, and MCAS data from 2004-05 through 2009-2010, which were analyzed to identify the predictive indicators in each grade (see Exhibit Middle School.2).

**Exhibit Middle School.2. Numbers of students and schools by data source**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Passing All courses Grade 9 | | | | |
| Source Data | Passed all Courses in Grade 9 | Failed one or more courses grade 9 | #  Students |  |
| Grade 6 in 2006-07  (used to create 7th grade model) | 686 (65%) | 369 (35%) | 1,055[[15]](#footnote-15) |  |
| Grade 7 in 2007-08  (used to create 8th grade model) | 1,240 (62%) | 771 (38%) | 2,011 |  |
| Grade 8 in 2008-09  (used to create 9th grade model) | 1,292 (61%) | 827 (39%) | 2,119 |  |

The following strategies were employed in analyses:

* First, in order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, and other individual student variables that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The individual indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator. This analysis was used to inform the construction of the risk models tested.
* Then, based on the results of the simple logistic regression models, a series of analysis were conducted, including –
  + Student behavioral variables only;
  + Demographic variables along with the behavioral variables from the previous model;
  + Demographic variables, behavioral variables, and individual student variables including the availability of school wide Title I;
  + Demographic variables, behavioral variables, individual student variables including the availability of school wide Title I, and MEPA levels;
  + Demographic variables, behavioral variables, and individual student variables including the availability of school wide Title I, MEPA levels, and MCAS proficiency levels;
  + Demographic variables, behavioral variables, and individual student variables including the availability of school wide Title I, MEPA levels, MCAS proficiency levels, and district course data

## Seventh Grade: Analysis Results and Predicted Risk Levels

For seventh grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is highly predictive of whether a rising seventh grade student is at risk of not passing one or more courses in grade 9.

**Exhibit Grade7.1 Overview of Seventh Grade Risk Indicators**

|  |  |
| --- | --- |
| **Grade:** | **7 (using data from grade 6 students)** |
| **Age Grouping:** | Middle School (7th through 9th grade) |
| **Risk Indicators Tested:** | Behavioral variables   * Suspensions, end of year * Attendance rate, end of year * Mobility (more than one school within the school year) * Retention   Demographic variables   * Low income household- Free lunch * Low income household- Reduced price lunch * Special education level- Need greater than or equal to 2 hours or more * ELL status * Immigration status * Gender * Urban residence * Over age for grade (age 12 or older as of Sept 1 of 6th grade year)   Other individual student variables   * School wide Title I   MEPA levels   * Beginner level to Intermediate level is equal to 1; otherwise 0   6th Grade MCAS Proficiency Levels   * Math   + Warning   + Needs Improvement   + Proficient * ELA   + Warning   + Needs Improvement   + Proficient   District Course information   * Failed any Math * Failed any ELA * Failed any Science * Failed any Social Studies * Failed any non-core courses |
| **Academic Goal/ Outcome Variable:[[16]](#footnote-16)** | Passing all grade 9 courses |

NOTE: A total of 967 observations included this combined outcome variable for the final model. Approximately 65 percent did not fail any courses in grade 9, and the remaining 35 percent failed one or more courses.

### Seventh Grade: Simple Logistics – Analysis of Individual Indicators

In order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, other indicators, MEPA, MCAS, and district course data, tied to individual students that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The single indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator (Exhibit Grade7.2). This analysis was used to inform the construction of the final risk model (Exhibit Grade7.3).

**Exhibit Grade7.2. Simple Logistic Regression Overview, Grade 7**

| **Simple Logistic regression: Individual indicators (predictor)** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Estimate** | **S.E.** | **Pr > ChiSq** | **R-Square** | **N** |
| ***Demographic variables (Yes/No)*** |  |  |  |  |  |
| **Low income household- Free lunch** | 1.68 | 0.15 | <.0001 | 0.1314 | 1,055 |
| **Low income household- Reduced price lunch** | 1.41 | 0.23 | <.0001 |
| **Special education**:  Greater than or equal to 2 hours or more | 0.98 | 0.17 | <.0001 | 0.0318 | 1,055 |
| **Immigration status**† | 0.32 | 0.40 | 0.4291 | 0.0006 | 1,055 |
| **Sex: Female** | -0.43 | 0.13 | 0.0010 | 0.0102 | 1,055 |
| **ELL status**† | 1.36 | 0.36 | 0.0002 | 0.0146 | 1,055 |
| **Overage for grade†** | 1.05 | 0.16 | <.0001 | 0.0382 | 1,055 |
| **Urban residence** | 1.66 | 1.66 | <.0001 | 0.1181 | 1,055 |
| ***Behavioral Variables*** |  |  |  |  |  |
| **Suspensions, end of year** | 0.84 | 0.17 | <.0001 | 0.0430 | 1,055 |
| **Attendance rate, end of year** | -20.90 | 2.12 | <.0001 | 0.1151 | 1,055 |
| **Retained** | 1.73 | 1.16 | 0.1358 | 0.0025 | 1,055 |
| **Mobility, Changed schools during school year (Yes/No)** † | 1.18 | 0.27 | .0002 | 0.0189 | 1,055 |
| ***Title I participation (Yes/No)*** |  |  |  |  |  |
| **School-wide** | 1.67 | 0.14 | <.0001 | 0.1338 | 1,055 |
| ***MEPA Levels (Yes/No)*** |  |  |  |  |  |
| **Low level** (Beginner to intermediate) | 1.60 | 0.45 | 0.0004 | 0.0137 | 1,055 |
| ***6th grade MCAS*** |  |  |  |  |  |
| ***ELA*** |  |  |  |  |  |
| **Warning** | 3.76 | 0.52 | <.0001 | 0.217 | 1,754 |
| **Needs Improvement** | 2.74 | 0.48 | <.0001 |
| **Proficient**† | 0.89 | 0.48 | 0.061 |
| ***MATH*** |  |  |  |
| **Warning** | 3.97 | 0.47 | <.0001 | 0.1413 | 1,765 |
| **Needs Improvement** | 2.82 | 0.47 | <.0001 |
| **Proficient**† | 2.00 | 0.48 | <.0001 |
| ***District Course Data (Yes/No)*** |  |  |  |  |  |
| **Fail any Math course** | 2.77 | 0.76 | 0.0003 | 0.0788 | 984 |
| **Fail any ELA course** | 1.48 | 0.56 | 0.0085 |
| **Fail any Science course** | 2.82 | 1.06 | 0.0077 |
| **Fail any Social Studies course** | 0.27 | 0.84 | 0.7458 |
| **Fail any non-core course** | 3.00 | 0.74 | <.0001 | 0.0321 | 984 |

Exhibit Reads: students receiving free lunch services are 1.68 points higher than students without free lunch services in the log-odds of failing one or more courses in grade 9 (odds ratio = exp(1.68)=5.36).

†Indicator was removed from final analyses because the direction of the coefficient of the variable was changed adjusting for other variables in the equation, or the estimated coefficient was nearly zero, or the predictive power of the model decreased.

### Seventh Grade: Overview of Risk Model

Exhibit Grade7.3 provides the summary statistics for the final model. The estimates in column 2 denote the expected difference in the log-odds of not passing all courses in grade 9, holding constant other variables in the model. For example, students that are low income (free lunch) are expected to score 0.46 points higher than other students in the log-odds of failing at least one course in grade 9, holding other variables constant. They also have about one and half times (exp(0.46)=1.58) the risk of failing one or more courses in grade 9 than students who are not eligible for free lunch. Overall, with the exception of attendance and gender, all other variables are statistically positively associated with the recoded outcome variable (not passing all 9th grade courses) at an alpha level of .10.

**Exhibit Grade7.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, MCAS Levels and District Course Data and Middle School Outcome Variable (Failing one or more 9th grade courses), Grade 7**

| **Variable** | **Odds Ratio** | **Estimate** | **S.E.** | **Pr > |t|** | |
| --- | --- | --- | --- | --- | --- |
| Behavioral variables |  |  |  |  | |
| Attendance rate, end of year | <0.001 | -14.42 | 2.68 | <.0001 | |
| Suspensions, end of year | 1.37 | 0.31 | 0.18 | 0.08 | |
| Retained | 1.30 | 0.26 | 1.35 | 0.84 | |
| Demographic variables |  |  |  |  | |
| Low income household- Free lunch | 1.58 | 0.46 | 0.22 | 0.03 | |
| Low income household- Reduced price lunch | 2.16 | 0.77 | 0.30 | 0.01 | |
| Special Education (greater than or equal to 2 or more hours of need) | 0.94 | 0.06 | 0.05 | 0.09 | |
| Urban residence | 1.17 | 0.16 | 0.27 | 0.55 | |
| Sex: Female | 0.72 | -0.32 | 0.18 | 0.07 | |
| Other variables |  |  |  |  | |
| School wide Title I | 2.06 | 0.73 | 0.22 | 0.001 | |
| MEPA Levels |  |  |  |  | |
| Low level (Beginner to intermediate) | 1.13 | 0.12 | 0.15 | 0.08 | |
| 6th grade MCAS |  |  |  |  | |
| ELA |  |  |  |  | |
| Warning | 3.30 | 1.20 | 0.37 | 0.001 | |
| Needs Improvement | 2.40 | 0.88 | 0.21 | <.0001 | |
| Math |  |  |  |  | |
| Warning | 8.60 | 2.15 | 0.52 | <.0001 | |
| Needs Improvement | 5.59 | 1.72 | 0.50 | 0.001 | |
| Proficient | 4.00 | 1.39 | 0.50 | 0.006 | |
| District Course Data |  |  |  |  | |
| Fail any math course | 4.60 | 1.53 | 0.80 | 0.057 | |
| Fail any ELA course | 1.15 | 0.14 | 0.61 | 0.814 | |
| Fail any Science course | 9.02 | 2.20 | 1.15 | 0.055 | |
| Fail any noncore course | 3.75 | 1.72 | 0.82 | 0.03 | |
| r2=0.354  Number of observations= 967  Note: some variables that are not statistically significantly predictive at an alpha level of .10 - retained, urban, and ‘fail any ELA course’ – were still included in the final model based on the evidence that these variables were predictive in early age groups with the state-wide data or based on discussion of course-relevant variables. These variables will be retested once statewide data are available. | | | | |

### 

### Seventh Grade: Illustration of Levels of Risk and Outcome Using the Final Model

Based on the distributions of scores by increased risk in failing to pass all grade nine courses, the levels of risk are defined as follows:

* Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-2;
* Moderate Risk (approximately half or more than half of the students meet the outcome variable): Intervals 3-5; and
* High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

The statistics for the final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade7.4 and Grade7.5. In summary, approximately 92 percent of students who fall into the low risk category have passed all 9th grade courses. Of the students who are categorized in the moderate risk category, approximately 67 percent of the students have met the outcome. Among the high risk students only 24 percent passed all 9th grade courses and 76 percent of the students failed one or more.

**Exhibit Grade7.4. Final Model – Risk Level Based on Model, Grade 7**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Total numbers of students in sample by risk levels** | | | | | |
| Increased risk level | Estimate For Probability of Risk | Frequency | No to low risk | Moderate risk | High risk |
| 1 | ≤ 0.1 | 267 | 267 | 0 | 0 |
| 2 | >0.1 & ≤ 0.2 | 161 | 161 | 0 | 0 |
| 3 | >0.2 & ≤ 0.3 | 104 | 0 | 104 | 0 |
| 4 | >0.3& ≤ 0.4 | 75 | 0 | 75 | 0 |
| 5 | >0.4 & ≤ 0.5 | 69 | 0 | 69 | 0 |
| 6 | >0.5 & ≤ 0.6 | 59 | 0 | 0 | 59 |
| 7 | >0.6 & ≤ 0.7 | 60 | 0 | 0 | 60 |
| 8 | >0.7 & ≤ 0.8 | 63 | 0 | 0 | 63 |
| 9 | >0.8 | 109 | 0 | 0 | 109 |
| Total |  | 967 | 428 | 248 | 291 |

**Exhibit Grade7.5. Final Model - Predictive Probability of Outcome Based on Risk Level, Grade 7**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictive Probability of Passing all 9th Grade Courses Based on Risk Level** | | | |
|  | ***9th Grade Outcomes*** | |  |
|  | **Failed one or more courses** | **Passed all 9th grade courses** |  |
|  |  |
| ***Risk Level*** | **Total** |
| **Low** | 35  10.74% | 393  91.82% | 428 |
| **Moderate** | 82  33.06% | 166  66.94% | 248 |
| **High** | 220  75.60% | 71  24.30% | 291 |
| **Total** | 337  34.85% | 630  65.15% | 967 |

### Seventh Grade: Alternate Model for students without Course Performance

ESE ran into complications in using the Final Seventh Grade EWIS model with 2011-12 statewide data. A large number of student course data for middle school students, especially those in sixth grade, lacked appropriate course performance information to be used in the above model. Instead, the majority/entirety of their courses was noted as non-graded. This was most common for students enrolled in a K-6 schools. Nearly 20% of 2011-12 sixth graders were unable to get EWIS risk level through the seventh grade model due to insufficient course performance information. To address this problem, an alternate model that does not include course performance information was created. Students who lacked grades/performance information in the SCS data set to allow for coding as failing or passing were provided a EWIS risk level based on this model. This model was still predictive, but had a lower predictive power than the final seventh grade EWIS risk model that did include course performance data. This model is found Appendix A.1.

As done in earlier grades, students who lacked MCAS information were placed in moderate risk (see Technical Document: Early and Late Elementary Age Groupings for further discussion).

## Eighth Grade: Analysis Results and Predicted Risk Levels

For eighth grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is highly predictive of whether a rising eighth grade student is at risk of not passing one or more courses in grade 9.

**Exhibit Grade8.1 Overview of Eighth Grade Risk Indicators**

|  |  |
| --- | --- |
| **Grade:** | **8 (using data from grade 7 students)** |
| **Age Grouping:** | Middle School (7th through 9th grade) |
| **Risk Indicators Tested:** | Behavioral variables   * Suspensions, end of year * Attendance rate, end of year * Mobility (more than one school within the school year) * Retention   Demographic variables   * Low income household- Free lunch * Low income household- Reduced price lunch * Special education level- Need greater than or equal to 2 hours or more * ELL status * Immigration status * Gender * Urban residence * Over age for grade ( age 13 or older as of Sept 1 of 7th grade year)   Other individual student variables   * School wide Title I   MEPA levels  • Beginner to intermediate  7th Grade MCAS Proficiency Levels   * Math   + Warning   + Needs Improvement   + Proficient * ELA   + Warning   + Needs Improvement   + Proficient   District Course information   * Failed any Math * Failed any ELA * Failed any Science * Failed any Social Studies * Failed any non-core courses |
| **Academic Goal/ Outcome Variable:[[17]](#footnote-17)** | Pass all 9th grade courses |

NOTE: A total of 1958 observations included this combined outcome variable for the final model. Approximately 63 percent did not fail any courses in grade 9, and the remaining 37 percent failed one or more courses.

### Eighth Grade: Simple Logistics – Analysis of Individual Indicators

In order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, other indicators, MEPA, MCAS, and district course data, tied to individual students that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The single indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator (Exhibit Grade8.2). This analysis was used to inform the construction of the final risk model (Exhibit Grade8.3).

**Exhibit Grade8.2. Simple Logistic Regression Overview, Grade 8**

| **Simple Logistic regression: Individual indicators (predictor)** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Estimate** | **S.E.** | **Pr > ChiSq** | **R-Square** | **N** |
| ***Demographic variables (Yes/No)*** |  |  |  |  |  |
| **Low income household- Free lunch** | 1.14 | 0.10 | <.0001 | 0.0642 | 2,011 |
| **Low income household- Reduced price lunch** | 0.86 | 0.16 | <.0001 |
| **Special education:**  Greater than or equal to 2 hours or more | 0.93 | 0.13 | <.0001 | 0.0266 | 2,011 |
| **Immigration status**† | 0.15 | 0.21 | 0.4923 | 0.0002 | 2,011 |
| **Sex: Female** | -0.56 | 0.09 | <.0001 | 0.0204 | 2,011 |
| **ELL status**† | 0.39 | 0.21 | 0.0699 | 0.0016 | 2,011 |
| **Overage for grade** † | 0.95 | 0.12 | <.0001 | 0.0320 | 2,011 |
| **Urban residence** | 1.51 | 0.14 | <.0001 | 0.0689 | 2,011 |
| ***Behavioral Variables*** |  |  |  |  |  |
| **Suspensions, end of year** | 0.88 | 0.09 | <.0001 | 0.0981 | 2,011 |
| **Attendance rate, end of year** | -16.42 | 1.22 | <.0001 | 0.1123 | 2,011 |
| **Retained†** | 0.59 | 0.46 | 0.2042 | 0.0008 | 2,011 |
| ***Mobility - Changed schools during school year (Yes/No)*** † | 0.73 | 0.20 | 0.0003 | 0.0064 | 2,011 |
| ***Title I participation (Yes/No)*** |  |  |  |  |  |
| **School-wide** | 1.18 | 0.10 | <.0001 | 0.0678 | 2,011 |
| ***MEPA Levels (Yes/No)*** |  |  |  |  |  |
| **Low level** (Beginner to intermediate) † | 0.50 | 0.21 | 0.0183 | 0.0027 | 2,011 |
| ***7th grade MCAS*** |  |  |  |  |  |
| ***ELA*** |  |  |  |  |  |
| **Warning** | 3.51 | 0.41 | <.0001 | 0.1390 | 1,961 |
| **Needs Improvement** | 3.05 | 0.40 | <.0001 |
| **Proficient**† | 1.74 | 0.40 | <.0001 |
| ***MATH*** |  |  |  |  |  |
| **Warning** | 3.57 | 0.40 | <.0001 | 0.178 | 1,996 |
| **Needs Improvement** | 2.48 | 0.40 | <.0001 |
| **Proficient** | 1.35 | 0.40 | <.0001 |
| ***District Course Data (Yes/No)*** |  |  |  |  |  |
| **Fail any Math course** | 1.79 | 0.29 | <.0001 | 0.0901 | 2,011 |
| **Fail any ELA course** | 1.17 | 0.34 | 0.0006 |
| **Fail any Science course** | 1.41 | 0.34 | <.0001 |
| **Fail any Social Studies course** | 2.31 | 0.62 | 0.0002 |
| **Fail any non-core course** | 1.94 | 0.28 | <.0001 | 0.0297 | 2,011 |

Exhibit Reads: students receiving free lunch services are 1.14 points higher than students without free lunch services in the log-odds of failing one or more courses in grade 9 (odds ratio = exp(1.14)=3.38).

†Indicator was removed from final analyses because the direction of the coefficient of the variable was changed adjusting for other variables in the equation, or the estimated coefficient was nearly zero, or the predictive power of the model decreased.

### Eighth Grade: Final Risk Model

Exhibit Grade8.3 provides the summary statistics for the final model. The estimates in column 2 show the odds ratio, while the estimates in column 3 denote the expected difference in the log-odds of not passing all courses in grade 9, holding constant other variables in the model. For example, students that are low income (free lunch) are expected to score 0.26 points higher than other students in the log-odds of failing at least one course in grade 9, holding other variables constant. They also have 1.297 times the risk of failing one or more courses in grade 9 than students who are not eligible for free lunch.

With the exception of attendance, low income (reduced price lunch), fail ELA or Science, and gender variables, all other variables are statistically positively associated with the recoded outcome variable (not passing all their 9th grade courses) at an alpha level of .10. Note that attendance is statistically negatively associated with the recoded outcome variable[[18]](#footnote-18).

**Exhibit Grade8.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MCAS and District Course Data**

| **Variable** | **Odds Ratio** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- | --- |
| Behavioral variables |  |  |  |  |
| Attendance rate, end of year | <0.001 | -10.11 | 1.40 | <.0001 |
| Suspensions, end of year | 1.47 | 0.39 | 0.09 | <.0001 |
| Demographic variables |  |  |  |  |
| Low income household- Free lunch | 1.26 | 0.23 | 0.14 | 0.09 |
| Low income household- Reduced lunch | 1.29 | 0.25 | 0.20 | 0.22 |
| Special education:  Greater than or equal to 2 hours or more | 1.03 | 0.03 | 0.18 | 0.88 |
| Urban residence | 1.70 | 0.53 | 0.19 | 0.01 |
| Sex: Female | 0.58 | -0.55 | 0.12 | <.0001 |
| Other variables |  |  |  |  |
| School wide Title I | 2.00 | 0.69 | 0.13 | <.0001 |
| MEPA |  |  |  |  |
| Low Level (beginner to intermediate) | .98 | 0.019 | .335 | 0.59 |
| 7th grade MCAS |  |  |  |  |
| ELA |  |  |  |  |
| Warning | 1.51 | 0.41 | 0.24 | 0.09 |
| Needs Improvement | 1.57 | 0.45 | 0.14 | 0.01 |
| Math |  |  |  |  |
| Warning | 11.67 | 2.46 | 0.45 | <.0001 |
| Needs Improvement | 5.95 | 1.78 | 0.44 | <.0001 |
| Proficient | 3.33 | 1.20 | 0.45 | 0.01 |
| District Course Data |  |  |  |  |
| Fail any Math course | 2.76 | 1.02 | 0.34 | <.0001 |
| Fail any ELA course | 1.17 | 0.16 | 0.40 | 0.69 |
| Fail any Science course | 1.50 | 0.41 | 0.40 | 0.31 |
| Fail any Social Studies course | 5.67 | 1.74 | 0.67 | 0.01 |
| Fail any noncore course | 2.17 | 0.77 | 0.35 | 0.03 |
| r2=0.315  Number of observations=1958  Note: some variables that are not statistically significantly predictive at an alpha level of .10 - low income household-reduced lunch, special education, ‘fail any ELA course’, and ‘fail any science course’ – were still included in the final model based on the evidence that either variables were predictive in early age groups with the state-wide data or based on discussion of course-relevant variables. These variables will be retested once statewide data are available. | | | | |

### Eighth Grade: Illustration of Levels of Risk and Outcome Using the Final Model

Based on the distributions of scores by increased risk in failing to graduate from High School on time, the levels of risk are defined as follows:

* Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-2;
* Moderate Risk (approximately half or more than half of the students meet the outcome variable): Intervals 3-5; and
* High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

The statistics for the final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade8.4 and Grade8.5. In summary, 92 percent of students who fall into the low risk category have passed all 9th grade courses. Of the students who are categorized in the moderate risk category, approximately 64 percent of the students have met the outcome. Among the high risk students only 27 percent passed all 9th grade courses and 73 percent of the students failed one or more.

**Exhibit Grade8.4. Final Model – Risk Level Based on Model, Grade 8**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Total numbers of students in sample by risk levels** | | | | | |
| Increased risk level | Estimate For Probability of Risk | Frequency | No to low risk | Moderate risk | High risk |
| 1 | ≤ 0.1 | 363 | 363 | 0 | 0 |
| 2 | >0.1 & ≤ 0.2 | 312 | 312 | 0 | 0 |
| 3 | >0.2 & ≤ 0.3 | 266 | 0 | 266 | 0 |
| 4 | >0.3& ≤ 0.4 | 205 | 0 | 205 | 0 |
| 5 | >0.4 & ≤ 0.5 | 188 | 0 | 188 | 0 |
| 6 | >0.5 & ≤ 0.6 | 144 | 0 | 0 | 144 |
| 7 | >0.6 & ≤ 0.7 | 152 | 0 | 0 | 152 |
| 8 | >0.7 & ≤ 0.8 | 107 | 0 | 0 | 107 |
| 9 | >0.8 | 221 | 0 | 0 | 221 |
| Total |  | 1,958 | 675 | 659 | 624 |

**Exhibit Grade8.5. Final Model - Predictive Probability of Outcome Based on Risk Level, Grade 8**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictive Probability of Passing all 9th Grade Courses Based on Risk Level** | | | |
|  | ***9th Grade Outcomes*** | |  |
|  | **Failed one or more courses** | **Passed all 9th grade courses** |  |
|  |  |
| ***Risk Level*** | **Total** |
| **Low** | 54 8.00% | 621 92.00% | 675 |
| **Moderate** | 238 34.12% | 421 63.88% | 659 |
| **High** | 418 72.76% | 149 27.24% | 624 |
| **Total** | 746  38.10% | 1,212  61.90% | 1,958 |

### Eighth Grade: Alternate Model for students without Course Performance

ESE ran into complications in using the Eighth Grade final model with 2011-12 statewide data. As was found for sixth graders, a number of student course data for middle school students lacked appropriate course performance information to be used in the above model. Instead, the majority/entirety of their courses was noted as non-graded. As was done for the seventh grade model, an alternate model that does not include course performance information was created. Students who lacked grades/performance information in the SCS data set to allow for coding as failing or passing were provided a EWIS risk level based on this alternate model. This model was still predictive, but had a lower predictive power than the final eighth grade EWIS risk model that did include course performance data. This model is found Appendix A.2.

As done in earlier grades, students who lacked MCAS information were placed in moderate risk (see Technical Document: Early and Late Elementary Age Groupings for further discussion).

## Ninth Grade: Analysis Results and Predicted Risk Levels

For ninth grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that seems highly predictive of whether a rising ninth student is at risk of not passing one or more courses in grade 9.

**Exhibit Grade9.1 Overview of Ninth Grade Model Risk Indicators**

|  |  |
| --- | --- |
| **Grade:** | **9 (using data from grade 8 students)** |
| **Age Grouping:** | Middle School (7th through 9th grade) |
| **Risk Indicators Tested:** | Behavioral variables   * Suspensions, end of year * Attendance rate, end of year * Mobility (more than one school within the school year) * Retention   Demographic variables   * Low income household- Free lunch * Low income household- Reduced price lunch * Special education level- Need greater than or equal to 2 hours or more * Immigration status * Gender * Urban residence * Over age for grade ( age 14 older as of Sept 1 of 8th grade year)   Other individual student variables   * School wide Title I   MEPA levels  • Beginner to intermediate  8th Grade MCAS Proficiency Levels   * Math   + Warning   + Needs Improvement   + Proficient * ELA   + Warning   + Needs Improvement   + Proficient   District Course information   * Failed any Math * Failed any ELA * Failed any Science * Failed any Social Studies * Failed any non-core courses |
| **Academic Goal/ Outcome Variable:[[19]](#footnote-19)** | Pass all 9th grade courses |

NOTE: A total of 1978 observations included this combined outcome variable for the final model. Approximately 61 percent did not fail any courses in grade 9, and the remaining 39 percent failed one or more courses.

### Ninth Grade: Simple Logistics – Analysis of Individual Indicators

In order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, other indicators, MEPA, MCAS, and district course data, tied to individual students that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The single indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator (Exhibit Grade9.2). This analysis was used to inform the construction of the final risk model (Exhibit Grade9.3).

**Exhibit Grade9.2. Simple Logistic Regression Overview, Grade 9**

| **Simple Logistic regression: Individual indicators (predictor)** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Estimate** | **S.E.** | **Pr > ChiSq** | **R-Square** | **N** |
| ***Demographic variables (Yes/No)*** |  |  |  |  |  |
| **Low income household- Free lunch** | 1.16 | 0.10 | <.0001 | 0.0661 | 2,119 |
| **Low income household- Reduced price lunch** | 0.82 | 0.16 | <.0001 |
| **Special education**: †  Greater than or equal to 2 hours or more | 0.78 | 0.14 | <.0001 | 0.0144 | 2,119 |
| **Immigration status**† | -0.03 | 0.20 | 0.8975 | 0.0000 | 2,119 |
| **Sex: Female** | -0.61 | 0.09 | <.0001 | 0.0218 | 2,119 |
| **ELL status**† | 0.14 | 0.18 | 0.4150 | 0.0003 | 2,119 |
| **Overage for grade** † | 0.95 | 0.11 | <.0001 | 0.0336 | 2,119 |
| **Urban residence** | 1.87 | 0.18 | <.0001 | 0.0730 | 2,119 |
| ***Behavioral Variables*** |  |  |  |  |  |
| **Suspensions, end of year** | 0.74 | 0.07 | <.0001 | 0.0925 | 2,119 |
| **Attendance rate, end of year** | -15.22 | 1.04 | <.0001 | 0.1325 | 2,119 |
| **Retained**† | 2.45 | 0.62 | <.0001 | 0.0129 | 2,005 |
| ***Mobility - Changed schools during school year (Yes/No)*** † | 1.04 | 0.19 | <.0001 | 0.0153 | 2,119 |
| ***Title I participation (Yes/No)*** |  |  |  |  |  |
| **School-wide** | 0.76 | 0.09 | <.0001 | 0.0328 | 2,119 |
| ***MEPA Levels (Yes/No)*** |  |  |  |  |  |
| **Low level**(Beginner to intermediate) | 0.33 | 0.20 | 0.1011 | 0.0013 | 2,119 |
| ***8th grade MCAS*** |  |  |  |  |  |
| ***ELA*** |  |  |  |  |  |
| **Warning** | 3.53 | 0.38 | <.0001 | 0.151 | 2,042 |
| **Needs Improvement** | 3.32 | 0.35 | <.0001 |
| **Proficient**† | 1.90 | 0.35 | <.0001 |
| ***MATH*** |  |  |  |  |  |
| **Warning** | 3.42 | 0.42 | <.0001 | 0.209 | 2,047 |
| **Needs Improvement** | 2.23 | 0.42 | <.0001 |
| **Proficient** | 1.09 | 0.44 | <.0001 |
| ***District Course Data (Yes/No)*** |  |  |  |  |  |
| **Fail any Math course** | 1.68 | 0.35 | <.0001 | 0.1110 | 2,119 |
| **Fail any ELA course** | 3.23 | 0.60 | <.0001 |
| **Fail any Science course** | 2.07 | 0.50 | <.0001 |
| **Fail any Social Studies course** | 1.57 | 0.44 | 0.0004 |
| **Fail any non-core course** | 2.13 | 0.24 | <.0001 | 0.0483 | 2,119 |

Exhibit Reads: students receiving free lunch services are 1.16 points higher than students without free lunch services in the log-odds of failing one or more courses in grade 9 (odds ratio = exp(1.16)=3.19).

†Indicator was removed from final analyses because the direction of the coefficient of the variable was changed adjusting for other variables in the equation, or the estimated coefficient was nearly zero, or the predictive power of the model decreased.

### Ninth Grade: Final Risk Model

Exhibit Grade9.3 provides the summary statistics for the final model. The estimates in column 2 show the odds ratio, while the estimates in column 3 denote the expected difference in the log-odds of not passing all courses in grade 9, holding constant other variables in the model. For example, students that are low income (free lunch) are expected to score 0.33 points higher than other students in the log-odds of failing at least one course in grade 9, holding other variables constant. They also have 1.39 times the risk of failing one or more courses in grade 9 than students who are not eligible for free lunch.

**Exhibit Grade9.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, MCAS Levels, and District Course Data**

| **Variable** | **Odds Ratio** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- | --- |
| Behavioral variables |  |  |  |  |
| Attendance rate, end of year | <0.001 | -10.51 | 1.31 | <.0001 |
| Suspensions, end of year | 1.23 | 0.21 | 0.07 | 0.00 |
| Retained | 2.77 | 1.02 | 0.68 | 0.13 |
| Demographic variables |  |  |  |  |
| Low income household- Free lunch | 1.39 | 0.33 | 0.14 | 0.02 |
| Low income household- Reduced lunch | 1.20 | 0.18 | 0.21 | 0.38 |
| Urban residence | 2.37 | 0.86 | 0.24 | <.0001 |
| Sex: Female | 0.57 | -0.56 | 0.12 | <.0001 |
| Other variables |  |  |  |  |
| School wide Title I | 1.55 | 0.44 | 0.13 | <.0001 |
| MEPA Levels |  |  |  |  |
| Low level (Beginner to intermediate) | 1.37 | 0.32 | 0.36 | 0.38 |
| 8th grade MCAS |  |  |  |  |
| ELA |  |  |  |  |
| Warning | 2.59 | 0.95 | 0.44 | 0.03 |
| Needs Improvement | 3.84 | 1.35 | 0.40 | 0.00 |
| Proficient | 2.09 | 0.74 | 0.38 | 0.05 |
| Math |  |  |  |  |
| Warning | 7.41 | 2.00 | 0.33 | <.0001 |
| Needs Improvement | 3.46 | 1.24 | 0.32 | <.0001 |
| Proficient | 1.60 | 0.47 | 0.33 | 0.16 |
| District Course Data |  |  |  |  |
| Fail any Math course | 1.29 | 0.25 | 0.41 | 0.54 |
| Fail any ELA course | 15.47 | 2.74 | 0.75 | <.0001 |
| Fail any Science course | 2.80 | 1.03 | 0.57 | 0.07 |
| Fail any Social Studies course | 2.60 | 0.95 | 0.55 | 0.08 |
| Fail any noncore course | 3.56 | 1.27 | 0.31 | <.0001 |
| r2=0.3602  Number of observations=1978  Note: some variables that are not statistically significantly predictive at an alpha level of .10 – low income (reduced lunch), Math-proficient, failing math, MEPA– were still included in the final model. These variables will be reviewed once statewide data are available. | | | | |

### Ninth Grade: Illustration of Levels of Risk and Outcome Using the Final Model

Based on the distributions of scores by increased risk in failing one or more 9th grade courses, the levels of risk are defined as follows:

* Low Risk (approximately 75% or more of students meet the outcome variable): Intervals 1-2;
* Moderate Risk (approximately half or more than half of the students meet the outcome variable): Intervals 3-5; and
* High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

The statistics for the final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade9.4 and Grade9.5. In summary, approximately 92 percent of students who fall into the low risk category have passed all 9th grade courses. Of the students who are categorized in the moderate risk category, approximately 65 percent of the students have met the outcome. Among the high risk students only 24 percent passed all 9th grade courses and 76 percent of the students failed one or more.

**Exhibit Grade9.4. Final Model – Risk Level Based on Model, Grade 9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Total numbers of students in sample by risk levels** | | | | | |
| Increased risk level | Estimate For Probability of Risk | Frequency | No to low risk | Moderate risk | High risk |
| 1 | ≤ 0.1 | 449 | 449 | 0 | 0 |
| 2 | >0.1 & ≤ 0.2 | 302 | 302 | 0 | 0 |
| 3 | >0.2 & ≤ 0.3 | 194 | 0 | 194 | 0 |
| 4 | >0.3& ≤ 0.4 | 186 | 0 | 186 | 0 |
| 5 | >0.4 & ≤ 0.5 | 155 | 0 | 155 | 0 |
| 6 | >0.5 & ≤ 0.6 | 151 | 0 | 0 | 151 |
| 7 | >0.6 & ≤ 0.7 | 158 | 0 | 0 | 158 |
| 8 | >0.7 & ≤ 0.8 | 110 | 0 | 0 | 110 |
| 9 | >0.8 | 273 | 0 | 0 | 273 |
| Total |  | 1,978 | 751 | 535 | 692 |

**Exhibit Grade9.5. Final Model - Predictive Probability of Outcome Based on Risk Level, Grade 9**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictive Probability of Passing all 9th Grade Courses Based on Risk Level** | | | |
| ***Risk Level*** | ***9th Grade Outcomes*** | | **Total** |
| **Failed one or more courses** | **Passed all 9th grade courses** |
| **Low** | 60 7.99% | 691 92.01% | 751 |
| **Moderate** | 184 33.39% | 351 65.61% | 535 |
| **High** | 524 75.72% | 168  24.28% | 692 |
| **Total** | 768  38.83% | 1,210  61.17% | 1,978 |

### Ninth Grade: Alternate Model for students without Course Performance

ESE ran into complications in using the Ninth Grade final model with 2011-12 statewide data. As was found for the earlier middle school models, student course data for a subset of students lacked appropriate course performance information to be used in the above model. Instead, the majority/entirety of their courses was noted as non-graded. To provide risk levels for these students and for consistency with the other middle school age group models, an alternate model that does not include course performance information was created. Students who lacked grades/performance information in the SCS data set to allow for coding as failing or passing were provided a EWIS risk level based on this alternate model. This model was still predictive, but had a lower predictive power than the final ninth grade EWIS risk model that did include course performance data (shown above). The alternate model without course performance data is found Appendix A.3.

As done in earlier grades, students who lacked MCAS information were placed in moderate risk (see Technical Document: Early and Late Elementary Age Groupings for further discussion).

## Middle School Validation: Comparison of 2008-09 and 2009-10 Cohort

In order show the strength of the final model in other cohorts, the following tables examine the extent to which the developed risk model using the original cohort data correctly identified at-risk students in the validation cohort among those who actually met the predefined outcome measure (passing all 9th grade courses). As shown in Middle School Validation.1, overall the predictive probability of proficiency by risk level is very similar between the original cohort and the validation cohort for grades 7, 8 and 9 and falls within the acceptable parameters for each risk level.

Exhibit Middle School Validation.2shows the output from the logistical regression for grade 7, 8, and 9 models using the original cohort and the validation cohort. In general, the coefficients are all similar in magnitude and significance, though there are exceptions. There is some variation in low income, ELA MCAs variables and some of course performance areas across cohorts. Retention also varied significantly, and this may be a result of a small number of retained students in the validation cohort. As we use statewide data sets, we will continue to see if retention remains significant, and/or retest overage for inclusion. The directions of the coefficients are the same between the model, except special education which not changes in significance as well as direction. As we move to a state level data set we hope to make this variable more refined. Attention will continue to be paid to the magnitude of the variable in the upper grades.

In sum, the validation work suggests that the final models for the middle school age grouping are generally strong across cohorts. The consistency of the coefficients between cohorts implies that the selected indicators are behaving similarly in reference to our outcome variable in different groups.We will continue to test the prediction accuracy and stability of the EWIS models for other cohorts as more recent data sets become available, especially statewide data.

**Exhibit Middle School Validation.1 Predictive Probability of Proficiency Original Cohort vs. Validation Cohort, Grades 7-9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Predictive Probability of Meeting Outcome Based on Risk Level**  **SEVENTH GRADE** | | | | | |
|  | **Failed one or more 9th grade courses** | | **Passed all 9th grade courses** | | |
| ***Risk Level*** | **Original** | **Validation** | **Original** | **Validation** | |
| **cohort** | **cohort** | **cohort** | **cohort** | |
| **Low** | 35  8.17% | 42  8.15% | 393  91.82% | 473  91.85 | |
| **Moderate** | 82  33.06% | 117  39.80% | 166  66.94% | 177  60.20% | |
| **High** | 220  75.60% | 243  70.23% | 71  24.30% | 103  29.77% | |
| **Total** | 337  34.85% | 402  34.81% | 630  65.15% | 753  65.85% | |
| **Predictive Probability of Meeting Outcome Based on Risk Level**  **EIGHTH GRADE** | | | | | |
| ***Risk Level*** | **Failed one or more 9th grade courses** | | **Passed all 9th grade courses** | | |
| **Original** | **Validation** | **Original** | **Validation** | |
| **cohort** | **cohort** | **cohort** | **cohort** | |
| **Low** | 54 8.00% | 44  6.42% | 621 92.00% | 641  93.58% | |
| **Moderate** | 238 34.12% | 210  33.28% | 421 65.88% | 421  66.72% | |
| **High** | 418 72.76% | 464  70.62 | 149 27.24% | 193  29.38% | |
| **Total** | 746  38.10% | 718  36.39% | 1,212  61.90% | 1,255  63.61% | |
| **Predictive Probability of Meeting Outcome Based on Risk Level**  **NINTH GRADE** | | | | | |
|  | **Failed one or more 9th grade courses** | | **Passed all 9th grade courses** | | |
| ***Risk Level*** |
| **Original** | **Validation** | **Original** | | **Validation** |
| **cohort** | **cohort** | **cohort** | | **cohort** |
| **Low** | 60 7.99% | 70  8.12% | 691 92.01% | | 792  91.88% |
| **Moderate** | 184 33.39% | 220  40.29% | 351 65.61% | | 326  59.71% |
| **High** | 524 75.72% | 468  72.44% | 168  24.28% | | 178  27.56% |
| **Total** | 768  38.83% | 758  36.90% | 1,210  61.17% | | 1,296  63.10% |

**Exhibit Middle School Validation.2. Overview of Findings by Cohort Using Final Model**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Grade 7** | | **Grade 8** | | **Grade 9** | |
| **Variable** | **Original Cohort** | **Validation Cohort** | **Original Cohort** | **Validation Cohort** | **Original Cohort** | **Validation Cohort** |
| Behavioral variables |  |  |  |  |  |  |
| Attendance rate, end of year | -14.42\*\*\* | -8.47\*\*\* | -10.11\*\*\* | 11.10\*\*\* | -10.51\*\*\* | -11.34\*\*\* |
| Suspensions, end of year | 0.31\* | 0.26\* | 0.39\*\*\* | 0.35\*\*\* | 0.21\*\*\* | 0.29\*\*\* |
| Retained | 0.26 | 2.07 | - | - | 1.02 | 0.59 |
| Demographic variables |  |  |  |  |  |  |
| Low income household- Free lunch | 0.46\*\* | 0.649\*\* | 0.23\* | 0.55\*\*\* | 0.33\*\* | 0.44\*\*\* |
| Low income household- Reduced lunch | 0.77\*\*\* | 0.59\*\* | 0.25 | 0.09 | 0.18 | 0.40\* |
| Special education:  Greater than or equal to 2 hours or more | 0.06\* | -0.02 | 0.03\*\* | -0.12 | - | - |
| Urban residence | 0.16 | 0.57\*\* | 0.53 | 0.25 | 0.86\*\*\* | 0.36\*\* |
| Sex: Female | -0.32\* | -0.54\*\*\* | -0.55\*\*\* | -0.47\*\*\* | -0.56\*\*\* | -0.51\*\*\* |
| Other variables |  |  |  |  |  |  |
| School wide Title I | 0.73\*\*\* | 0.78\*\*\* | 0.69\*\*\* | 0.48\*\* | 0.44\*\* | 0.14 |
| MEPA Levels |  |  |  |  |  |  |
| Low level (Beginner to intermediate) | 0.12\* | 0.33 | 0.02 | 0.09 | 0.32 | 0.09 |
| MCAS |  |  |  |  |  |  |
| ELA |  |  |  |  |  |  |
| Warning | 1.20\*\*\* | 0.83\*\* | 0.41\* | 0.39 | 0.95\*\* | 1.29\*\*\* |
| Needs Improvement | 0.88\*\*\* | 0.66\* | 0.45\*\*\* | 0.45\*\*\* | 1.35\*\*\* | 1.64\*\*\* |
| Proficient | - | - | - | - | 0.74\*\* | 1.24\*\*\* |
| Math |  |  |  |  |  |  |
| Warning | 2.15\*\*\* | 2.07\*\*\* | 2.46\*\*\* | 3.48\*\*\* | 2.00\*\*\* | 2.48\*\*\* |
| Needs Improvement | 1.72\*\*\* | 1.75\*\*\* | 1.78\*\*\* | 2.89\*\*\* | 1.24\*\*\* | 1.99\*\*\* |
| Proficient | 1.39\*\* | 0.83\*\* | 1.20\*\*\* | 1.20\*\*\* | 0.47\* | 1.20\*\*\* |
| District Course Data |  |  |  |  |  |  |
| Fail any Math course | 1.53\* | 0.21 | 1.02\*\*\* | 1.41\*\*\* | 0.25 | 0.91\*\* |
| Fail any ELA course | 0.14 | 0.93 | 0.16 | 1.33\*\*\* | 2.74\*\*\* | 1.29\*\*\* |
| Fail any Science course | 2.20\* | 0.94 | 0.41 | 0.61\* | 1.03\* | 2.22\*\*\* |
| Fail any Social Studies course | - | - | 1.74\*\*\* | 0.16 | 0.95\* | 1.22\*\* |
| Fail any noncore course | 1.72\*\* | 1.17\* | 0.77\*\* | 1.06\*\*\* | 1.27\* | 0.45 |

\* Significant at 10%, \*\*Significant at 5%, \*\*\*Significant at 1%

- variable not included in model

# High School Age Group (Grades 10 through 12)

The High School Age Group encompasses grade 10 through 12, using data from students ninth, tenth and eleventh grade years.[[20]](#footnote-20) Within the age group indicators of risk were tested at each grade level based on the outcome variable of graduating high school in 4 years, as determined by the ESE.

## Potential Indicators

In the High School Age Group, the indicators tested include data from several state databases (SIMS, MCAS, MEPA) that include behavioral, demographic, other variables including academic performance data. Behavioral indicators are mutable and considered manifestations of student behavior (e.g., attendance, suspensions). Demographic indicators are tied to who the child is, and are not necessarily based on a student’s behavior (although some of these, such as low income household, may change over time). Other individual student indicators are focused on characteristics related to the community in which the student resides and the type of services the student receives. The high school analysis relies on several indicators of skill assessments including course performance[[21]](#footnote-21), MEPA levels and the MCAS proficiency[[22]](#footnote-22) in mathematics and English language arts as well as student course performance, which results in substantial improvement of prediction accuracy. *Exhibit High School.1* provides a summary of the indicators that were tested in the high school grades.[[23]](#footnote-23)

**Exhibit High School.1. Indicator Definitions, by Type**

| **Type** | **Indicator** | **Definition** | | | | **Corresponding**  **Data Source** |
| --- | --- | --- | --- | --- | --- | --- |
| **Outcome Variable** | |  | |  | |  |
|  | Graduate from High School On Time (4 years) | Binary variable: 1= Graduated high school within 4 years; 0=Did not graduate within 4 years  Indicates students who graduate high school on time. | | | | MA DESE Cohort Graduation List |
| **Behavioral Variable** | | |  | |  |  |
|  | Attendance | Continuous variable: Attendance rate, end of year- number of days in attendance over the number of days in membership | | | | SIMS DOE045  SIMS DOE046 |
|  | Suspension | Continuous variable: Suspensions, end of year - number of days in school suspension plus number of days out of school suspension | | | | SIMS DOE017  SIMS DOE018 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Mobility**[[24]](#footnote-24)** | Binary variable: 1=School code changes from beginning of school year to end of school year; 0= School code is the same at beginning and end of school year | | | SIMS 8 digit school identifier |
| **Demographic variable** | | |  |  |  |
|  | Gender | Binary variable: 1=Female; 0=Male | | | SIMS DOE009 |
|  | Low income household – Free lunch | Binary variable: 1=Free lunch eligible; 0= not eligible | | | SIMS DOE019 |
|  | Low income household – Reduced price lunch | Binary variable: 1=Reduced lunch recipient; 0= Not eligible for reduced price lunch | | | SIMS DOE019 |
|  | ELL program | Binary variable: 1= sheltered English Immersion (SEI) or 2-way bilingual or other;  0 = opt out, no program | | | SIMS DOE014 |
|  | Over age for grade [[25]](#footnote-25) | Binary variable: 1=Age of student is equal or greater than two years older than expected grade level age as of September 1 in a given year. 0= Age of child is less than two years older than expected grade level year. (e.g. student is 16 years or older as of September 1 of 9th grade year) | | | SIMS DOE006 |
|  | Immigration Status | Binary variable: 1= Student is an immigrant under the federal definition; 0=Student is not an immigrant | | | SIMS DOE022 |
|  | Urban residence | Binary variable: 1=Student lives in an urban area[[26]](#footnote-26); 0= Student does not live in one of the specified urban areas | | | SIMS DOE014 |
|  | Special Education – Level of Need | Special Education – Multiple indicators   * Dummy variable: Low level of need (less than 2 hours) is equal to 1; otherwise 0. * Dummy variable: Low level of need (2 or more hours) is equal to 1; otherwise 0. * Dummy variable: Moderate level of need is equal to 1; otherwise 0. * Dummy variable: High level of need is equal to 1; otherwise 0. | | | SIMS DOE038 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Other Individual Student Variable** | | | | |  |  |  |
|  | | Title I participation[[27]](#footnote-27) | Binary variables:   * School -wide Title I, Binary variable: 1= School-wide Title I; 0= Not school-wide Title I | | | | SIMS DOE020 |
| **MEPA Levels** | | | |  | | |  |
|  | Massachusetts English Proficiency Assessment (MEPA) | | Binary indicator   * Beginner level to Intermediate level is equal to 1; otherwise 0. | | | | MEPA Spring data variable name:  pl |
| **MCAS Proficiency Levels** | | | | | | | |
|  | | MCAS Proficiency levels in Math and English and English (as available) [[28]](#footnote-28) | Multiple indicators   * Math[[29]](#footnote-29)   + Dummy variable: Warning is equal to 1; otherwise 0.   + Dummy variable: Needs improvement is equal to 1; otherwise 0.   + Dummy variable: Proficient is equal to 1; otherwise 0. * English   + Dummy variable: Warning is equal to 1; otherwise 0.   + Dummy variable: Needs improvement is equal to 1; otherwise 0.   + Dummy variable: Proficient is equal to 1; otherwise 0. | | | | MCAS data for cohort in analysis  name:  EPERF2 MPERF2 |
| **Course Outcomes** | | | | | | | |
|  | | Course Information | District Course information   * Failed any Math   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any ELA   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any Science   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any Social Studies   + Dummy variable: Failed equal to 1; otherwise 0. * Failed any non-core courses   + Dummy variable: Failed equal to 1; otherwise 0. * Flag Math Course   + Dummy variable: Missing math course equal to 1; otherwise 0. * Flag ELA Course   + Dummy variable: Missing ELA course equal to 1; otherwise 0. * Flag Science Course   + Dummy variable: Missing science course equal to 1; otherwise 0. * Flag Social Studies Course   + Dummy variable: Missing SS course equal to 1; otherwise 0. * Flag non-core Course   + Dummy variable: Missing non-core course equal to 1; otherwise 0. | | | | Data from pilot districts |

## Analysis Methods and Strategies

To identify the model that most accurately predicts risk of not achieving proficiency on timely graduation, we conducted multiple analyses. A separate analysis was conducted in each grade to designate a risk level for students as they enter the next year: tenth grade (using students 9th grade information), eleventh grade (using students 10th grade information) and twelfth grade (using students 11th grade information).

For risk model development for the high school age group, we focused on 2008-09 graduation cohort and relied on a sample of students provided by seven districts. These students were linked with SIMS data in 2005-06 through 2007-08, and MCAS data from 2004-05 through 2009-10, which were analyzed to identify the predictive indicators in each grade (see Exhibit High School.2).

**Exhibit High School.2. Numbers of students and schools by data source**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| On-time Graduation for 2008-09 cohort | | | | |
| Source Data | Graduated in 4 years | Did not graduate in 4 years | #  Students | # Districts |
| Grade 9 in 2005-06  (used to develop 10th grade model) | 2,224(75%) | 748 (25%) | 2,972 | 7 |
| Grade 10 in 2006-07  (used to develop 11th grade model) | 2,210 (14%) | 362 (14%) | 2,572 | 7 |
| Grade 11 in 2007-08  (used to develop 12th grade model) | 2,318 (89%) | 276 (11%) | 2,594 | 7 |

The following strategies were employed in analyses:

* First, in order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, and other individual student variables that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator.
* The individual indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator. This analysis was used to inform the construction of the risk models tested.
* Then, based on the results of the simple logistic regression models, a series of analysis were conducted, including –
  + Student behavioral variables only;
  + Demographic variables along with the behavioral variables from the previous model;
  + Demographic variables, behavioral variables, and individual student variables including the availability of school wide Title I;
  + Demographic variables, behavioral variables, individual student variables including the availability of school wide Title I, and MEPA levels;
  + Demographic variables, behavioral variables, and individual student variables including the availability of school wide Title I, MEPA levels, and MCAS proficiency levels[[30]](#footnote-30);
  + Demographic variables, behavioral variables, and individual student variables including the availability of school wide Title I, MEPA levels, and MCAS proficiency levels; and district course data

## Tenth Grade: Analysis Results and Predicted Risk Levels

For tenth grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is most predictive of whether a rising tenth grade student is at risk of not meeting the outcome variable of graduating high school on time.

**Exhibit Grade10.1 Overview of Tenth Grade Risk Indicators**

|  |  |
| --- | --- |
| **Grade:** | **10 (using data from grade 9 students)** |
| **Age Grouping:** | High School (10th through 12th grade) |
| **Risk Indicators Tested:** | Behavioral variables[[31]](#footnote-31)   * Suspensions, end of year * Attendance rate, end of year * Mobility (more than one school within the school year)   Demographic variables   * Low income household- Free lunch * Low income household- Reduced price lunch * Special education level variables (4 total) * ELL status * Immigration status * Gender * Urban residence * Over age for grade (age 16 or older by Sept 1st of 9th grade year)   Other individual student variables   * School wide Title I   MEPA levels  • Beginner to intermediate  8th Grade MCAS Proficiency Levels[[32]](#footnote-32)   * Math   + Warning   + Needs Improvement   + Proficient   District Course information   * Failed any Math * Failed any ELA * Failed any Science * Failed any Social Studies * Failed any non-core courses * Missing Math Course * Missing ELA Course * Missing Science Course * Missing Social Studies Course * Missing non-core course |
| **Academic Goal/ Outcome Variable:[[33]](#footnote-33)** | On-time graduation |

NOTE: A total of 2717 observations included this combined outcome variable for the final model. Approximately 76 percent graduated within 4 years, and the remaining 24 percent did not.

### Tenth Grade: Simple Logistics – Analysis of Individual Indicators

In order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, other indicators, previous outcomes for MEPA, and district course data, tied to individual students that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The single indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator (Exhibit Grade10.2). This analysis was used to inform the construction of the final risk model (Exhibit Grade10.3).

**Exhibit Grade10.2. Simple Logistic Regression Overview, Grade 10**

| **Simple Logistic regression: Individual indicators (predictor)** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Estimate** | **S.E.** | **Pr > ChiSq** | **R-Square** | | **N** |
| ***Demographic variables (Yes/No)*** |  |  |  |  | |  |
| **Low income household- Free lunch** | 1.74 | 0.07 | <.0001 | 0.0714 | | 2,972 |
| **Low income household- Reduced price lunch** | 0.55 | 0.17 | 0.0012 |
| **Special education** |  |  |  |  | |  |
| Low level of need (less than 2 hours)† | 0.58 | 0.35 | 0.1010 | 0.0573 | | 2,972 |
| Low level of need (2 or more hours) | 1.08 | 0.23 | <.0001 |
| Moderate level of need | 1.12 | 0.14 | <.0001 |
| High level of need | 2.89 | 0.33 | <.0001 |
| **Immigration status**† | 0.33 | 0.19 | 0.0825 | 0.0010 | | 2,972 |
| **Sex: Female** | -0.82 | 0.06 | <.0001 | 0.0234 | | 2,972 |
| **ELL status**† | 0.55 | 0.17 | 0.0008 | 0.0035 | | 2,972 |
| **Overage for grade** | 1.89 | 0.23 | <.0001 | 0.0233 | | 2,972 |
| **Urban residence**† | 1.05 | 0.11 | <.0001 | 0.0343 | | 2,972 |
| ***Suspension*** |  |  |  |  | |  |
| **Suspensions, end of year** | 0.36 | 0.02 | <.0001 | 0.1827 | | 2,972 |
| ***Attendance*** |  |  |  |  | |  |
| **Attendance rate, end of year** | -17.50 | 0.87 | <.0001 | 0. 2609 | | 2,972 |
| ***Mobility - Changed schools during school year (Yes/No)*** † | 1.13 | 0.14 | <.0001 | 0.0205 | | 2,972 |
| ***Title I participation (Yes/No)*** |  |  |  |  | |  |
| **School-wide** | 0.80 | 0.10 | <.0001 | 0. 0229 | | 2,972 |
| ***MEPA Levels (Yes/No)*** |  |  |  |  | |  |
| **Low level** | 0.73 | 0.18 | <.0001 | 0.0050 | | 2,972 |
| ***8th grade MCAS*** |  |  |  |  | |  |
| ***MATH*** |  |  |  |  | |  |
| **Warning** | 2.72 | 0.33 | <.0001 | 0.1446 | | 2,718 |
| **Needs Improvement** | 1.31 | 0.34 | 0.0001 |
| **Proficient** | 0.26 | 0.37 | 0.4691 |
| ***District Course Data (Yes/No)[[34]](#footnote-34)*** |  |  |  |  | |  |
| **Fail any math course**† | 1.09 | 0.16 | <.0001 | 0.3291 | 2,971 | |
| **Fail any ELA course** | 1.85 | 0.19 | <.0001 |
| **Flagged as missing ELA** | 1.05 | 0.31 | 0.0007 |
| **Fail any Science course** | 1.25 | 0.17 | <.0001 |
| **Flagged as missing Science** | 1.51 | 0.16 | <.0001 |
| **Fail any Social Studies course** | 1.25 | 0.18 | <.0001 |
| **Flagged as missing Social Studies** | 1.76 | 0.26 | <.0001 |

Exhibit Reads: students with a high level of need are 2.89 higher in the log-odds of not graduating school on time.

†Indicator was removed from final analyses because the direction of the coefficient of the variable was changed adjusting for other variables in the equation, or the estimated coefficient was nearly zero, or the predictive power of the model decreased.

### Tenth Grade: Final Risk Model

Exhibit Grade10.3 provides the summary statistics for the final model. The estimates in column 2 denote the expected difference in the log-odds of not graduating in four years—on time graduation, holding constant other variables in the model. For example, students that are overage are expected to score 1.12 points higher than other students in the log-odds of not graduating high school on time, holding other variables constant. They also have 3.08 times the risk of not graduating within four years than other students. With the exception of attendance, suspension, and low income (reduced price lunch), as well as flagged as missing ELA and proficiency(‘needs improvement’ and ‘proficient’) in Math MCAS, all other variables are statistically positively associated with the recoded outcome variable (not gradating in 4 years) at an alpha level of .10. Attendance is statistically negatively associated with the recoded outcome variable[[35]](#footnote-35).

**Exhibit Grade10.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, 8th grade Math MCAS, and District Course Data, Grade 10**

| **Variable** | **Odds Ratio** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- | --- |
| Behavioral variables |  |  |  |  |
| Attendance rate, end of year | <.0001 | -6.82 | 1.06 | <.0001 |
| Suspensions, end of year | 1.04 | 0.04 | 0.02 | 0.127 |
| Demographic variables |  | 0.48 | 0.15 | 0.001 |
| Low income household- Free lunch | 1.61 | 0.48 | 0.15 | 0.001 |
| Low income household- Reduced price lunch | 1.30 | 0.26 | 0.26 | 0.311 |
| Special Education |  |  |  |  |
| Low level of need (2 or more hours) | 1.45 | 0.37 | 0.36 | 0.296 |
| Moderate level of need | 1.54 | 0.43 | 0.21 | 0.041 |
| High level of need | 13.15 | 2.58 | 0.42 | <.0001 |
| Sex: Female | 0.64 | -0.45 | 0.14 | 0.001 |
| Overage (Age 16 or older Sept 1st of 9th grade year) | 3.08 | 1.12 | 0.45 | 0.013 |
| Other variables |  |  |  |  |
| School wide Title I | 1.59 | 0.46 | 0.16 | 0.005 |
| MEPA Levels |  |  |  |  |
| Low level (Beginner to intermediate) | 2.37 | 0.86 | 0.41 | 0.037 |
| 8th grade MCAS Proficiency Levels |  |  |  |  |
| MATH |  |  |  |  |
| Warning | 2.87 | 1.05 | 0.41 | 0.010 |
| Needs Improvement | 1.85 | 0.62 | 0.41 | 0.134 |
| Proficient | 1.32 | 0.28 | 0.44 | 0.528 |
| District Course Data |  |  |  |  |
| Fail any math course | 1.64 | 0.49 | 0.19 | 0.010 |
| Fail any ELA course | 3.96 | 1.38 | 0.22 | <.0001 |
| Fail any Science course | 1.82 | 0.60 | 0.20 | 0.003 |
| Fail any Social Studies course | 1.85 | 0.62 | 0.22 | 0.004 |
| Flagged as missing ELA | 1.16 | 0.15 | 0.42 | 0.728 |
| Flagged as missing Science | 1.97 | 0.68 | 0.23 | 0.003 |
| Flagged as missing Social Studies | 3.64 | 1.29 | 0.39 | 0.001 |
| Fail any noncore course | 3.00 | 1.10 | 0.16 | <.0001 |
| Flagged as missing noncore | 2.35 | 0.85 | 0.47 | 0.067 |
| r2=0.4142  Number of observations=2717  Note: some variables that are not statistically significantly predictive at an alpha level of .10 - low income (reduced lunch), special education (low-level of need) and ‘flagged as missing ELA’ – were still included in the final model. Thus, these variables should be re-tested once statewide data are available. | | | | |

### Tenth Grade: Illustration of Levels of Risk and Outcome Using the Final Model

Based on the distributions of scores by increased risk in failing to graduate from High School on time, the levels of risk are defined as follows:

* Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-2;
* Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 3-5; and
* High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

The statistics for the final model’s three levels of risk (low risk; moderate risk; and high risk) are shown in Exhibits Grade10.4 and Grade10.5.

**Exhibit Grade10.4. Final Model – Risk Level Distributions, Grade 10**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Total numbers of students in sample by risk levels** | | | | | |
| Increased risk level | Estimate For Probability of Risk | Frequency | No to low risk | Moderate risk | High risk |
| 1 | ≤ 0.1 | 1,586 | 1,586 | 0 | 0 |
| 2 | >0.1 & ≤ 0.2 | 289 | 289 | 0 | 0 |
| 3 | >0.2 & ≤ 0.3 | 141 | 0 | 141 | 0 |
| 4 | >0.3& ≤ 0.4 | 103 | 0 | 103 | 0 |
| 5 | >0.4 & ≤ 0.5 | 65 | 0 | 65 | 0 |
| 6 | >0.5 & ≤ 0.6 | 69 | 0 | 0 | 69 |
| 7 | >0.6 & ≤ 0.7 | 62 | 0 | 0 | 62 |
| 8 | >0.7 & ≤ 0.8 | 64 | 0 | 0 | 64 |
| 9 | >0.8 | 338 | 0 | 0 | 338 |
| Total |  | 2,717 | 1,875 | 309 | 533 |

**Exhibit Grade10.5. Final Model - Predictive Probability of Graduating in Four Years Based on Risk Level, Grade 10**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictive Probability of Meeting Outcome Based on Risk Level** | | | |
| ***Risk Level*** | ***Graduated in 4 Years*** | | **Total** |
| **Did not Graduate** | **Graduated** |
| **Low** | 105 5.60% | 1,770 94.40% | 1,875 |
| **Moderate** | 112 36.25% | 197 63.75% | 309 |
| **High** | 437 81.99% | 96 18.01% | 533 |
| **Total** | 654  24.07% | 2,063  75.97% | 2,717 |

## Eleventh Grade: Analysis Results and Predicted Risk Levels

In eleventh grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is most predictive of whether a rising eleventh grade student is at risk of not meeting the outcome variable of graduating high school on time

**Exhibit Grade11.1 Overview of Eleventh Grade Risk Indicators**

|  |  |
| --- | --- |
| **Grade:** | **11 (using data from grade 10 students)** |
| **Age Grouping:** | High School (10th through 12th grade) |
| **Risk Indicators Tested:** | Behavioral variables   * Suspensions, end of year * Attendance rate, end of year * Mobility (more than one school within the school year)   Demographic variables   * Low income household- Free lunch * Low income household- Reduced price lunch * Special education level variables (4 total) * ELL status * Immigration status * Gender * Urban residence * Over age for grade (age 17 or older as of Sept 1st of 10th grade)   Other individual student variables   * School wide Title I   MEPA levels  • Beginner to intermediate  10th Grade MCAS Proficiency Levels   * Math   + Warning   + Needs Improvement   + Proficient * ELA   + Warning   + Needs Improvement   + Proficient   District Course Data   * Failed any Math * Failed any ELA * Failed any Science * Failed any Social Studies * Failed any non-core courses * Missing Math Course * Missing ELA Course * Missing Science Course * Missing Social Studies Course * Missing non-core course |
| **Academic Goal/ Outcome Variable:[[36]](#footnote-36)** | On-time graduation |

NOTE: A total of 2593 observations included this combined outcome variable for the final model. Approximately 86 percent graduated within 4 years, and the remaining 14 percent did not.

### Eleventh Grade: Simple Logistics – Analysis of Individual Indicators

In order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, other indicators, MEPA, MCAS, and district course data, tied to individual students that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The single indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator (Exhibit Grade11.2). This analysis was used to inform the construction of the final risk model (Exhibit Grade11.3).

**Exhibit Grade11.2. Simple Logistic Regression Overview, Grade 11**

| **Simple Logistic regression: Individual indicators (predictor)** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Estimate** | **S.E.** | **Pr > ChiSq** | **R-Square** | | **N** |
| ***Demographic variables (Yes/No)*** |  |  |  |  | |  |
| **Low income household- Free lunch** | 1.20 | 0.12 | <.0001 | 0.0380 | | 2,594 |
| **Low income household- Reduced price lunch** | 0.55 | 0.23 | 0.0181 |
| **Special education** |  |  |  |  | |  |
| Low level of need (less than 2 hours)† | 0.53 | 0.50 | 0.2827 | 0.0594 | | 2,594 |
| Low level of need (2 or more hours) | 0.40 | 0.39 | 0.3036 |
| Moderate level of need | 1.33 | 0.18 | <.0001 |
| High level of need | 3.50 | 0.38 | <.0001 |
| **Immigration status**† | 0.37 | 0.22 | 0.0979 | 0.0010 | | 2,594 |
| **Sex: Female**† | -0.47 | 0.11 | <.0001 | 0.0067 | | 2,594 |
| **ELL status**† | 0.79 | 0.19 | <.0001 | 0.0058 | | 2,594 |
| **Overage for grade** | 1.85 | 0.24 | <.0001 | 0.0208 | | 2,594 |
| **Urban residence** † | 0.77 | 0.14 | <.0001 | 0.0132 | | 2,594 |
| ***Suspension*** |  |  |  |  | |  |
| **Suspensions, end of year** | 0.29 | 0.02 | <.0001 | 0.0749 | | 2,594 |
| ***Attendance*** |  |  |  |  | |  |
| **Attendance rate, end of year** | -15.69 | 0.93 | <.0001 | 0. 1695 | | 2,594 |
| ***Mobility - Changed schools during school year (Yes/No)*** † | 1.46 | 0.22 | <.0001 | 0.0066 | | 2,594 |
| ***Title I participation (Yes/No)*** |  |  |  |  | |  |
| **School-wide** | 0.75 | 0.13 | <.0001 | 0. 0129 | | 2,594 |
| ***MEPA Levels (Yes/No)*** |  |  |  |  | |  |
| **Low level**† | 0.98 | 0.22 | <.0001 | 0.0066 | | 2,594 |
| ***10th grade MCAS*** |  |  |  |  | |  |
| ***ELA*** |  |  |  |  | |  |
| **Warning**† | 4.06 | 0.36 | <.0001 | 0.119 | | 2,483 |
| **Needs Improvement**† | 2.48 | 0.33 | <.0001 |
| **Proficient**† | 1.20 | 0.34 | <.0001 |
| ***MATH*** |  |  |  |  | |  |
| **Warning**† | 3.986 | .281 | <.0001 | 0.147 | | 2,471 |
| **Needs Improvement**† | 2.356 | .274 | <.0001 |
| **Proficient**† | 1.289 | .297 | <.0001 |
| ***District Course Data (Yes/No)*** |  |  |  |  | |  |
| **Fail any math course** | 1.15 | 0.18 | <.0001 | 0.2073 | 2,593 | |
| **Fail any ELA course** | 1.39 | 0.19 | <.0001 |
| **Flagged as missing ELA** | 1.04 | 0.38 | 0.0063 |
| **Fail any Science course** | 1.24 | 0.21 | <.0001 |
| **Flagged as missing Science** | 1.08 | 0.25 | <.0001 |
| **Fail any Social Studies course** | 1.39 | 0.20 | <.0001 |
| **Flagged as missing Social Studies** | 1.78 | 0.26 | <.0001 |
| **Fail any Non-core course** | 2.43 | 0.13 | <.0001 | 0.1294 | 2,593 | |
| **Flagged as missing Non-core** | 1.98 | 0.22 | <.0001 |

Exhibit Reads: students with a high level of need are 3.50 higher in the log-odds of not graduating school on time.

†Indicator was removed from final analyses because the direction of the coefficient of the variable was changed adjusting for other variables in the equation, or the estimated coefficient was nearly zero, or the predictive power of the model decreased.

### Eleventh Grade: Final Risk Model

Exhibit Grade11.3 provides the summary statistics for the final model. The estimates in column 2 denote the expected difference in the log-odds of not graduating in four years—on time graduation, holding constant other variables in the model. For example, students that are 17 or older are expected to score 0.40 points higher than other students in the log-odds of not graduating high school on time, holding other variables constant. This implies that they have 1.495 times the risk of not graduating high school on time than other students. With the exception of attendance, low income (reduced price lunch), low level of need, and gender, as well as flagged as missing science all other variables are statistically positively associated with the recoded outcome variable (not gradating in 4 years) at an alpha level of .10. Attendance is statistically negatively associated with the recoded outcome variable[[37]](#footnote-37).

**Exhibit Grade11.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, and District Course Data, Grade 11**

| **Variable** | **Odds Ratio** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- | --- |
| Behavioral variables |  |  |  |  |
| Attendance rate, end of year | <0.001 | -8.42 | 1.14 | <.0001 |
| Suspensions, end of year | 1.05 | 0.05 | 0.03 | 0.09 |
| Demographic variables |  |  |  |  |
| Low income household- Free lunch | 1.49 | 0.40 | 0.17 | 0.02 |
| Low income household- Reduced price lunch | 1.44 | 0.36 | 0.30 | 0.22 |
| Special Education |  |  |  |  |
| Low level of need (> 2 hours) | 1.61 | 0.47 | 0.47 | 0.31 |
| Moderate level of need | 3.87 | 1.35 | 0.24 | <.0001 |
| High level of need | 39.90 | 3.69 | 0.44 | <.0001 |
| Gender | 0.86 | -0.16 | 0.16 | 0.33 |
| Overage for Grade | 2.37 | 0.86 | 0.35 | 0.01 |
| MEPA Levels |  |  |  |  |
| Low level (Beginner to intermediate) | 1.44 | 0.36 | 0.36 | 0.31 |
| Other variables |  |  |  |  |
| School wide Title I | 1.49 | 0.40 | 0.19 | 0.03 |
| District Course Data |  |  |  |  |
| Fail any math course | 2.27 | 0.82 | 0.20 | <.0001 |
| Fail any ELA course | 2.52 | 0.93 | 0.22 | <.0001 |
| Fail any Science course | 2.02 | 0.70 | 0.23 | 0.00 |
| Fail any Social Studies course | 2.38 | 0.87 | 0.23 | <.0001 |
| Flagged as missing ELA | 2.56 | 0.94 | 0.47 | 0.05 |
| Flagged as missing Science | 1.25 | 0.22 | 0.30 | 0.47 |
| Flagged as missing Social Studies | 2.06 | 0.72 | 0.34 | 0.03 |
| Fail any noncore course | 2.28 | 0.83 | 0.20 | <.0001 |
| Flagged as missing noncore | 3.13 | 1.14 | 0.34 | 0.00 |
| r2=0.2917  Number of observations=2570  Note: some variables that are not statistically significantly predictive at an alpha level of .10 - low income (reduced lunch), gender, special education (low-level of need) and ‘flagged as missing science’ – were still included in the final model. Thus, these variables should be re-tested once statewide data are available. Urban indicator and ‘flagged as missing Math’ were not included because the coefficient was changed negatively on not graduating on time adjusting for other variables in the model. | | | | |

### Eleventh Grade: Illustration of Levels of Risk and Outcome Using the Final Model

Based on the distributions of scores by increased risk in failing to graduate from High School on time, the levels of risk are defined as follows:

* Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-2;
* Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 3-5; and
* High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

The statistics for the final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade11.4 and Grade11.5. In summary, approximately 95 percent of students who fall into the low risk category graduated on time. Of the students who are categorized in the moderate risk category, 65 percent of the students have met the outcome. Among the high risk students less than 25 percent graduated on time and nearly 75 percent of the students failed graduate in four years.

**Exhibit Grade11.4. Final Model – Risk Level Distributions, Grade 11**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Total numbers of students in sample by risk levels** | | | | | |
| Increased risk level | Estimate For Probability of Risk | Frequency | No to low risk | Moderate risk | High risk |
| 1 | ≤ 0.1 | 2,079 | 2,079 | 0 | 0 |
| 2 | >0.1 & ≤ 0.2 | 160 | 160 | 0 | 0 |
| 3 | >0.2 & ≤ 0.3 | 65 | 0 | 65 | 0 |
| 4 | >0.3& ≤ 0.4 | 59 | 0 | 59 | 0 |
| 5 | >0.4 & ≤ 0.5 | 32 | 0 | 32 | 0 |
| 6 | >0.5 & ≤ 0.6 | 35 | 0 | 0 | 35 |
| 7 | >0.6 & ≤ 0.7 | 30 | 0 | 0 | 30 |
| 8 | >0.7 & ≤ 0.8 | 29 | 0 | 0 | 29 |
| 9 | >0.8 | 104 | 0 | 0 | 104 |
| Total |  | 2,593 | 2,239 | 156 | 198 |

**Exhibit Grade11.5 Final Model - Predictive Probability of Graduating in Four Years Based on Risk Level, Grade 11**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictive Probability of Graduating in Four Years Based on Risk Level** | | | |
| ***Risk Level*** | ***Graduated in 4 Years*** | | **Total** |
| **Did not Graduate** | **Graduated** |
| **Low** | 99  4.68% | 2018  95.32% | 2239 |
| **Moderate** | 70  35.00% | 130  65.00% | 156 |
| **High** | 191  75.49% | 62  24.51% | 198 |
| **Total** | 360  14.01% | 2210  85.99% | 2593 |

## Twelfth Grade: Analysis Results and Predicted Risk Levels

For twelfth grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is most predictive of whether a rising twelfth grade student is at risk of not meeting the combined outcome variable of graduating high school on time.

**Exhibit Grade12.1 Overview of Twelfth Grade Risk Indicators**

|  |  |
| --- | --- |
| **Grade:** | **12 (using data from grade 11 students)** |
| **Age Grouping:** | High School (10th through 12th grade) |
| **Risk Indicators Tested:** | Behavioral variables   * Suspensions, end of year * Attendance rate, end of year * Mobility (more than one school within the school year)   Demographic variables   * Low income household- Free lunch * Low income household- Reduced price lunch * Special education level variables (4 total) * ELL status * Immigration status * Gender * Urban residence * Over age for grade (age 18 or older as of Sept 1st in 11th grade)   Other individual student variables   * School wide Title I   MEPA levels  • Beginner to intermediate  10th Grade MCAS Proficiency Levels   * Math   + Warning   + Needs Improvement   + Proficient * ELA   + Warning   + Needs Improvement   + Proficient   District Course information   * Failed any Math * Failed any ELA * Failed any Science * Failed any Social Studies * Failed any non-core courses * Missing Math Course * Missing ELA Course * Missing Science Course * Missing Social Studies Course |
| **Academic Goal/ Outcome Variable:[[38]](#footnote-38)** | On-time graduation |

NOTE: A total of 2383 observations included this combined outcome variable for the final model. Approximately 89 percent graduated within 4 years, and the remaining 11 percent did not.

### Twelfth Grade: Simple Logistics – Analysis of Individual Indicators

In order to build an efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, other indicators, MEPA, MCAS, and district course data, tied to individual students that may be considered in the resulting risk model. This analysis relied on simple logistic regressions for each individual indicator. The single indicator analyses allowed us to evaluate the statistical significance and coefficient for each indicator (Exhibit Grade12.2). This analysis was used to inform the construction of the final risk model (Exhibit Grade12.3).

**Exhibit Grade12.2. Simple Logistic Regression Overview, Grade 12**

| **Simple Logistic regression: Individual indicators (predictor)** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Estimate** | **S.E.** | **Pr > ChiSq** | **R-Square** | | **N** |
| ***Demographic variables (Yes/No)*** |  |  |  |  | |  |
| **Low income household- Free lunch**† | 1.06 | 0.13 | <.0001 | 0.0240 | | 2,594 |
| **Low income household- Reduced price lunch**† | 0.44 | 0.26 | 0.0895 |
| **Special education** |  |  |  |  | |  |
| Low level of need (less than 2 hours)† | 0.17 | 0.44 | 0.6887 | 0.0597 | | 2,594 |
| Low level of need (2 or more hours) | 0.09 | 0.47 | 0.8564 |
| Moderate level of need | 1.89 | 0.20 | <.0001 |
| High level of need | 3.51 | 0.39 | <.0001 |
| **Immigration status**† | 0.51 | 0.22 | 0.0212 | 0.0019 | | 2,594 |
| **Sex: Female** | -0.45 | 0.13 | 0.0004 | 0.0049 | | 2,594 |
| **ELL status**† | 0.85 | 0.20 | <.0001 | 0.0061 | | 2,594 |
| **Age 18 or above** | 1.51 | 0.23 | <.0001 | 0.0142 | | 2,594 |
| **Urban residence** † | 0.93 | 0.17 | <.0001 | 0.0139 | | 2,594 |
| ***Suspension*** |  |  |  |  | |  |
| **Suspensions, end of year** | 0.25 | 0.02 | <.0001 | 0.0519 | | 2,594 |
| ***Attendance*** |  |  |  |  | |  |
| **Attendance rate, end of year** | -12.86 | 0.76 | <.0001 | 0. 1611 | | 2,594 |
| ***Mobility- changed schools during school yr ( Yes/No)*** † | 1.53 | 0.20 | <.0001 | 0.0190 | | 2,594 |
| ***Title I participation (Yes/No)*** |  |  |  |  | |  |
| **School-wide** | 1.29 | 0.13 | <.0001 | 0. 0333 | | 2,594 |
| ***MEPA Levels (Yes/No)*** † |  |  |  |  | |  |
| **Low level** | 1.19 | 0.22 | <.0001 | 0.0091 | | 2,594 |
| ***10th grade MCAS*** |  |  |  |  | |  |
| ***ELA***† |  |  |  |  | |  |
| **Warning/Failing**† | 4.15 | 0.41 | <.0001 | 0.0981 | | 2,389 |
| **Needs Improvement**† | 2.42 | 0.40 | <.0001 |
| **Proficient**† | 1.29 | 0.40 | 0.0014 |
| ***MATH*** |  |  |  |  | |  |
| **Warning/Failing**† | 3.67 | 0.29 | <.0001 | 0.1062 | | 2,389 |
| **Needs Improvement**† | 2.15 | 0.29 | <.0001 |
| **Proficient**† | 1.15 | 0.31 | 0.0002 |
| ***District Course Data (Yes/No)*** |  |  |  |  | |  |
| **Fail any math course** | 1.48 | 0.19 | <.0001 | 0.2156 | 2,593 | |
| **Fail any ELA course** | 1.35 | 0.32 | <.0001 |
| **Flagged as missing ELA** | 1.43 | 0.21 | <.0001 |
| **Fail any Science course** | 0.94 | 0.42 | 0.0269 |
| **Flagged as missing Science** | 1.29 | 0.22 | <.0001 |
| **Fail any Social Studies course** | 1.92 | 0.22 | <.0001 |
| **Flagged as missing Social Studies** | 1.50 | 0.24 | <.0001 |
| **Fail any Non-core course** | 1.79 | 0.25 | <.0001 | 0.1068 | 2,593 | |
| **Flagged as missing Non-core** | 2.43 | 0.14 | <.0001 |
|  |  |  |  |  |  | |

Exhibit Reads: students with a high level of need are 3.51 higher in the log-odds of not graduating school on time.

†Indicator was removed from final analyses because the direction of the coefficient of the variable was changed adjusting for other variables in the equation, or the estimated coefficient was nearly zero, or the predictive power of the model decreased.

### Twelfth Grade: Final Risk Model

Exhibit Grade12.3 provides the summary statistics for the final model. The estimates in column 2 denote the expected difference in the log-odds of not graduating in four years—on time graduation, holding constant other variables in the model. For example, students that are overage for their grade are expected to score 1.45 points higher than other students in the log-odds of not graduating high school on time, holding other variables constant. This implies that students that are overage have 4.26 times the risk of not graduating high school on time than other students. With the exception of attendance and gender, as well as low level of need all other variables are statistically positively associated with the recoded outcome variable. Note that attendance is statistically negatively associated with the recoded outcome variable[[39]](#footnote-39).

**Exhibit Grade12.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, and District Course Data, Grade 12**

| **Variable** | **Odds Ratio** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- | --- |
| Behavioral variables |  |  |  |  |
| Attendance rate, end of year | <0.001 | -7.70 | 1.08 | <.0001 |
| Suspension, end of year | 1.04 | 0.04 | 0.03 | 0.19 |
| Demographic variables |  |  |  |  |
| Special Education |  |  |  |  |
| Low level of need (> 2 hours) | 1.98 | 0.69 | 0.57 | 0.23 |
| Moderate level of need | 7.25 | 1.98 | 0.29 | <.0001 |
| High level of need | 37.76 | 3.63 | 0.48 | <.0001 |
| Overage for grade (Age 18 or older Sept 1st of 11th gr) | 4.26 | 1.45 | 0.34 | <.0001 |
| Gender | 0.65 | -0.43 | 0.19 | 0.02 |
| Other variables |  |  |  |  |
| School wide Title I | 2.73 | 1.00 | 0.20 | <.0001 |
| District Course Data |  |  |  |  |
| Fail any math course | 3.16 | 1.15 | 0.23 | <.0001 |
| Fail any ELA course | 2.76 | 1.02 | 0.24 | <.0001 |
| Fail any Science course | 2.35 | 0.86 | 0.26 | 0.001 |
| Fail any Social Studies course | 3.11 | 1.14 | 0.28 | <.0001 |
| Flagged as missing Math | 1.31 | 0.27 | 0.37 | 0.47 |
| Flagged as missing ELA | 1.56 | 0.44 | 0.51 | 0.38 |
| Flagged as missing Science | 2.96 | 1.08 | 0.27 | <.0001 |
| Flagged as missing Social Studies | 3.54 | 1.26 | 0.29 | <.0001 |
| Fail any noncore course | 1.85 | 0.61 | 0.22 | 0.01 |
| Flagged as missing noncore | 4.75 | 1.56 | 0.42 | <.0001 |
| r2=0.2881  Number of observations=2383  Note: some variables that are not statistically significantly predictive at an alpha level of .10 – suspension, low level of need, flag for English and Math coursetaking– were still included in the final model. These variables will be re-evaluated once statewide data are available. | | | | |

### Twelfth Grade: Illustration of Levels of Risk and Outcome Using the Final Model

Based on the distributions of scores by increased risk in failing to graduate from high school on time, the levels of risk are defined as follows:

* Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-2;
* Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 3-5; and
* High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

The statistics for the final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade12.4 and Grade12.5. In summary, approximately 97 percent of students who fall into the low risk category graduated on time. Of the students who are categorized in the moderate risk category, approximately 65 percent of the students have met the outcome. Among the high risk students only 23 percent graduated on time and 77 percent of the students failed graduate in four years.

**Exhibit Grade12.4. Final Model – Risk Level Distributions, Grade 12**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Total numbers of students in sample by risk levels** | | | | | |
| Increased risk level | Estimate For Probability of Risk | Frequency | No to low risk | Moderate risk | High risk |
| 1 | ≤ 0.1 | 2079 | 2079 | 0 | 0 |
| 2 | >0.1 & ≤ 0.2 | 160 | 160 | 0 | 0 |
| 3 | >0.2 & ≤ 0.3 | 65 | 0 | 65 | 0 |
| 4 | >0.3& ≤ 0.4 | 59 | 0 | 59 | 0 |
| 5 | >0.4 & ≤ 0.5 | 32 | 0 | 32 | 0 |
| 6 | >0.5 & ≤ 0.6 | 35 | 0 | 0 | 35 |
| 7 | >0.6 & ≤ 0.7 | 30 | 0 | 0 | 30 |
| 8 | >0.7 & ≤ 0.8 | 29 | 0 | 0 | 29 |
| 9 | >0.8 | 104 | 0 | 0 | 104 |
| Total |  | 2,593 | 2,239 | 156 | 198 |

**Exhibit Grade12.5. Final Model - Predictive Probability of Graduating in Four Years Based on Risk Level, Grade 12**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictive Probability of Graduating in 4 Years Based on Risk Level** | | | |
| ***Risk Level*** | ***Graduated in 4 Years*** | | **Total** |
| **Did not Graduate** | **Graduated** |
| **Low** | 68  3.04% | 2171  96.94% | 2239 |
| **Moderate** | 55  35.26% | 101  64.74% | 156 |
| **High** | 152  76.77% | 46  23.23% | 198 |
| **Total** | 275  10.61% | 2318  89.39% | 2593 |

## High School Validation: Comparison of 2008-09 to 2009-10 Cohort

In order show the strength of the Final model in other cohorts, the following tables examine the extent to which the developed risk model using the original cohort data correctly identified at-risk students in the validation cohort among those who actually met the predefined outcome measure (graduating high school in four years). Exhibit High School Validation.1shows that overall, the predictive probability of proficiency by risk level is very similar between the original cohort and the validation cohort in grades 10, 11, and 12.

Exhibit High School Validation.2shows the output from the logistical regression for grade10, 11, and 12 models using the original cohort and the validation cohort. For grade 10, the coefficients are generally similar in magnitude and significance, except for MEPA (0.86 vs. 0.32), Fail any Math (0.49 vs 0.25), Fail any ELA (became statistically significant for Validation year), and Fail any noncore (1.10 vs. 0.59). For Grade 11, the coefficients are generally similar in magnitude and significance, except for gender (became significant in validation cohort) and missing ELA (0.94 vs. 1.88). More variation is seen in 12th grade model. In addition, the directions of the coefficients are the same between the models in all grades. Attention will continue to be paid to the magnitude of the variables in the high school model especially for grade 12.

In sum, the validation work suggests that the final models for high school age grouping are strong across cohorts. The general consistency of the coefficients between cohorts implies that the selected indicators are behaving similarly in reference to our outcome variable in different groups.We will continue to test the prediction accuracy and stability of the EWIS models for other cohorts as more recent data sets become available.

**Exhibit High School Validation.1 Predictive Probability of Proficiency Original Cohort vs. Validation Cohort, Grades 10-12**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Predictive Probability of Meeting Outcome Based on Risk Level**  **TENTH GRADE** | | | | | |
|  | **Did not graduate** | | **Graduate on time** | | |
| ***Risk Level*** | **2008-09** | **2007-18** | **2008-09** | **2007-08** | |
| **cohort** | **cohort** | **cohort** | **cohort** | |
| **Low** | 105 5.60% | 198  5.78% | 1,770 94.40% | 1,759  94.22% | |
| **Moderate** | 112 36.25% | 99  32.24% | 197 63.75% | 208  67.75% | |
| **High** | 437 81.99% | 443  81.28% | 96 18.01% | 102  18.78% | |
| **Total** | 654  24.07% | 650  23.91% | 2,063  75.97% | 2,069  76.09% | |
| **Predictive Probability of Meeting Outcome Based on Risk Level**  **ELEVENTH GRADE** | | | | | |
| ***Risk Level*** | **Did not graduate** | | **Graduate on time** | | |
| **2008-09** | **2009-10** | **2008-09** | **2009-10** | |
| **cohort** | **cohort** | **cohort** | **cohort** | |
| **Low** | 99  4.68% | 93  4.45% | 2,018  95.32% | 1,994  95.56% | |
| **Moderate** | 70  35.00% | 72  36.18% | 130  65.00% | 127  63.81% | |
| **High** | 191  75.49% | 202  79.84% | 62  24.51% | 51  20.16% | |
| **Total** | 360  14.01% | 367  14.45% | 2,210  85.99% | 2,172  85.54% | |
| **Predictive Probability of Meeting Outcome Based on Risk Level**  **TWELFTH GRADE** | | | | | |
| ***Risk Level*** | **Did not graduate** | | **Graduate on time** | | | |
| **2008-09** | **2009-10** | **2008-09** | | **2009-10** | |
| **cohort** | **cohort** | **cohort** | | **cohort** | |
| **Low** | 68  3.04% | 131  5.73% | 2,171  96.94% | | 2,153  94.26% | |
| **Moderate** | 55  35.26% | 61  43.57% | 101  64.74% | | 79  56.43% | |
| **High** | 152  76.77% | 175  84.13% | 46  23.23% | | 33  15.87% | |
| **Total** | 275  10.61% | 367  13.94% | 2,318  89.39% | | 2,265  86.06% | |

**Exhibit High School Validation.2. Overview of Findings by Cohort Using Final Model**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Grade 10** | | **Grade 11** | | **Grade 12** | |
| **Variable** | **Original Cohort**  **(2008-09)** | **Validation Cohort (2007-08)** | **Original Cohort**  **(2008-09)** | **Validation Cohort (2007-08)** | **Original Cohort**  **(2008-09)** | **Validation Cohort (2007-08)** |
| Behavioral variables |  |  |  |  |  |  |
| Attendance rate, end of year | -6.82\*\*\* | -7.82\*\*\* | -8.42\*\*\* | -5.44\*\*\* | -7.70\*\*\* | -5.77\*\*\* |
| Suspensions, end of year | 0.04 | 0.05 | 0.05\*\* | 0.06\*\* | 0.04 | 0.60\*\* |
| Demographic variables |  |  |  |  |  |  |
| Low income household- Free lunch | 0.48\*\*\* | 0.60\*\*\* | 0.40\*\*\* | 0.50\*\*\* | - | - |
| Low income household- Reduced price | 0.26 | 0.20 | 0.36 | 0.25 | - | - |
| Special Education |  |  |  |  |  |  |
| Low level of need (2 or more hours) | 0.37 | -0.20 | 0.47 | 0.52 | 0.69 | 0.52 |
| Moderate level of need | 0.43\*\* | 0.43\* | 1.35\*\*\* | 0.71\*\*\* | 1.98\*\*\* | 0.69\*\*\* |
| High level of need | 2.58\*\*\* | 1.14\*\*\* | 3.69\*\*\* | 2.35\*\*\* | 3.63\*\*\* | 2.77\*\*\* |
| Sex: Female | -0.45\*\*\* | -0.42\*\*\* | -0.16 | -0.25\*\*\* | -0.43\*\* | -0.22 |
| Overage for grade | 1.12\*\*\* | 1.51\*\*\* | 0.86\*\*\* | 1.12\*\*\* | 1.45\*\*\* | 1.22\*\*\* |
| Other variables |  |  |  |  |  |  |
| School wide Title I | 0.46\*\*\* | 0.72\*\*\* | 0.36\*\*\* | 0.89\*\*\* | 1.00\*\*\* | 0.89\*\*\* |
| MEPA Levels |  |  |  |  |  |  |
| Low level (Beginner to intermediate) | 0.86\*\* | 0.32 | 0.40 | 0.55 | - | - |
| 8th grade MCAS- Math |  |  |  |  |  |  |
| Warning | 1.05\*\*\* | 1.28\*\*\* | - | - | - | - |
| Needs Improvement | 0.62\* | 0.79\* | - | - | - | - |
| Proficient | 0.28 | 0.25 | - | - | - | - |
| District Course Data |  |  |  |  |  |  |
| Fail any math course | 0.49\*\*\* | 0.25\* | 0.82\*\*\* | 1.28\*\*\* | 1.15\*\*\* | 1.30\*\*\* |
| Fail any ELA course | 1.38 | 1.19\*\*\* | 0.93\*\*\* | 1.09\*\*\* | 1.02\*\*\* | 1.14\*\*\* |
| Fail any Science course | 0.60 | 0.76\*\*\* | 0.70\*\*\* | 0.72\*\*\* | 0.86\*\*\* | 0.75\*\*\* |
| Fail any Social Studies course | 0.60\* | 0.90\*\*\* | 0.87\*\* | 1.29\*\*\* | 1.14\*\*\* | 1.31\*\*\* |
| Flagged as missing Math |  |  |  |  | 0.27 | 1.30\*\* |
| Flagged as missing ELA | 0.15\*\*\* | 0.68\*\* | 0.94 | 1.88\*\*\* | 0.44 | 1.15\*\* |
| Flagged as missing Science | 0.68\*\*\* | 0.76\*\*\* | 0.22\*\*\* | 1.1\*\*\* | 1.08\*\*\* | 1.21\*\*\* |
| Flagged as missing Social Studies | 1.29\*\*\* | 1.18\*\*\* | 0.72\*\*\* | 0.86\*\* | 1.26\*\*\* | 0.95\* |
| Fail any noncore course | 1.10\*\*\* | 0.59 | 0.83\*\*\* | 0.94\*\*\* | 0.61\* | 0.95\*\*\* |
| Flagged as missing noncore | 0.85\*\*\* | 0.82\*\* | 1.14\*\*\* | 0.70 | 1.56\*\*\* | 0.72\* |

\* Significant at 10%, \*\*Significant at 5%, \*\*\*Significant at 1

- variable not included in model

# Appendix

### A.1 Seventh Grade: Alternate Risk Model- No Course Performance Data

**Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, MCAS Levels**

| **Variable** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- |
| Behavioral variables |  |  |  |
| Attendance rate, end of year | -13.85 | 2.48 | <.0001 |
| Suspensions, end of year | 0.35 | 0.18 | 0.05 |
| Retained | 0.14 | 0.36 | 0.92 |
| Demographic variables |  |  |  |
| Low income household- Free lunch | 0.54 | 0.21 | 0.01 |
| Low income household- Reduced price lunch | 0.68 | 0.29 | 0.02 |
| Special Education (greater than or equal to 2 or more hours of need) | 0.08 | 0.02 | 0.09 |
| Urban residence | 0.26 | 0.25 | 0.29 |
| Sex: Female | -0.44 | 0.17 | 0.01 |
| Other variables |  |  |  |
| School wide Title I | 0.73 | 0.22 | 0.001 |
| MEPA Levels |  |  |  |
| Low level (Beginner to intermediate) | 0.18 | 0.65 | 0.849 |
| Grade 6 MCAS |  |  |  |
| ELA |  |  |  |
| Warning | 1.38 | 0.35 | <.0001 |
| Needs Improvement | 0.86 | 0.20 | <.0001 |
| Math |  |  | <.0001 |
| Warning | 2.34 | 0.51 | <.0001 |
| Needs Improvement | 1.84 | 0.49 | <.0001 |
| Proficient | 1.48 | 0.50 | <.0001 |
| r2=0.30  Number of observations: 1,035 |  |  |  |

### A.2 Eighth Grade: Alternate Risk Model – No Course Performance Data

**Behavioral Variables, Demographic Variables, Other Variables, MCAS Levels.**

| **Variable** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- |
| Behavioral variables |  |  |  |
| Attendance rate, end of year | -10.87 | 1.36 | <.0001 |
| Suspensions, end of year | 0.47 | 0.09 | <.0001 |
| Demographic variables |  |  |  |
| Low income household- Free lunch | 0.24 | 0.14 | 0.07 |
| Low income household- Reduced lunch | 0.25 | 0.20 | 0.20 |
| Special education:  Greater than or equal to 2 hours or more | 0.08 | 0.08 | 0.64 |
| Urban residence | 0.49 | 0.19 | 0.01 |
| Sex: Female | -0.62 | 0.12 | <.0001 |
| Other variables |  |  |  |
| School wide Title I | 0.65 | 0.13 | <.0001 |
| MCAS Prior Year |  |  |  |
| ELA |  |  |  |
| Warning | 0.54 | 0.24 | 0.02 |
| Needs Improvement | 2.60 | 0.45 | 0.001 |
| Math |  |  |  |
| Warning | 2.60 | 0.45 | <.0001 |
| Needs Improvement | 1.86 | 0.44 | <.0001 |
| Proficient | 1.23 | 0.45 | <.0001 |
| r2=0.30  Number of observations: 1,958 |  |  |  |

### A.3 Ninth Grade: Alternate Risk Model- No Course Performance Data

**Behavioral Variables, Demographic Variables, Other Variables, MCAS Levels.**

| **Variable** | **Estimate** | **S.E.** | **Pr > |t|** |
| --- | --- | --- | --- |
| Behavioral variables |  |  |  |
| Attendance rate, end of year | -11.73 | 1.27 | <.0001 |
| Suspensions, end of year | 0.29 | 0.07 | 0.00 |
| Retained | 1.27 | 0.69 | 0.06 |
| Demographic variables |  |  |  |
| Low income household- Free lunch | 0.27 | 0.13 | 0.04 |
| Low income household- Reduced lunch | 0.17 | 0.20 | 0.38 |
| Urban residence | 0.79 | 0.23 | .001 |
| Sex: Female | -0.69 | 0.12 | <.0001 |
| Other variables |  |  |  |
| School wide Title I | 0.49 | 0.12 | <.0001 |
| MEPA Levels |  |  |  |
| Low level (Beginner to intermediate) | 0.23 | 0.36 | 0.52 |
| MCAS Prior Year |  |  |  |
| ELA |  |  |  |
| Warning | 1.12 | 0.43 | 0.01 |
| Needs Improvement | 1.48 | 0.40 | 0.00 |
| Proficient | 0.86 | 0.38 | 0.02 |
| Math |  |  |  |
| Warning | 2.08 | 0.32 | <.0001 |
| Needs Improvement | 1.28 | 0.31 | <.0001 |
| Proficient | 0.47 | 0.32 | 0.14 |
| r2=0.330  Number of observations = 1,958 |  |  |  |

# References

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Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Newbury Park, CA: Sage.

Schabenberger, O. (2005). Introducing the GLIMMIX procedure for generalized linear mixed models. Cary, NC: SAS Institute.

Therriault, S.; Burke, M. & Milligan, D. (2011). A Review of Birth through Twelfth Grade Early Warning Indicators for Consideration in the Massachusetts Early Warning Indicator System. Boston, MA: MA Executive Office of Education, Department of Early Education and Care, Elementary and Secondary Education, and Department of Higher Education.

1. HGLM models were not able to be used in the middle school and high school age groups since development of these age groups relied on a sample of district student course data, and therefore could not estimate the statewide school random effects for prediction. The late elementary model was updated to use more recent assessment data and, due to time constraints, the logistical regression model was employed. As state data become available for the middle and high school models, ESE will consider the feasibility of HGLM for EWIS model development. ESE will also consider using HGLM for the late elementary models. [↑](#footnote-ref-1)
2. At the middle and high school grades a sample of districts provided student course taking and course performance data to develop the statewide EWIS risk models. The sample size for middle and high school model development is therefore much smaller [↑](#footnote-ref-2)
3. Data from eight districts were provided, but inconsistencies or missing data in some districts made it necessary to exclude two districts. Thus, we ended up using data from six districts comprised of Brockton, Malden, Winchendon, Reading, Westport, and New Bedford. [↑](#footnote-ref-3)
4. In the middle school grades, MCAS scores were used when available. [↑](#footnote-ref-4)
5. The table includes all variables tested in the Middle School Age Group, but there may be variation in which of these were tested in individual grades. [↑](#footnote-ref-5)
6. Retention is defined from fall to fall. [↑](#footnote-ref-6)
7. Mobility was initially tested, but due to the course performance pilot, the variable was excluded. A large proportion of students who moved schools within the school year ended up lacking sufficient grade information and/or not being part of the outcome sample (by ninth grade they were not enrolled in a school that was taking part in the data pilot). This data point was considered different for this subgroup than the state as a whole. [↑](#footnote-ref-7)
8. Specified urban areas: Boston, Brockton, Cambridge, Chelsea, Chicopee, Everett, Fall River, Fitchburg, Framingham, Haverhill, Holyoke, Lawrence, Leominster, Lowell, Lynn, Malden, New Bedford, Pittsfield, Quincy, Revere, Somerville, Springfield, Taunton, Worcester. These are the urban districts during the years tested. Brockton, Malden and New Bedford were part of data pilot. [↑](#footnote-ref-8)
9. Originally special education variable has 4 categories based on levels of need of special education: 1) Low- less than 2 hours, 2) Low - 2 or more hours, 3) Moderate, and 4) High. Each indicators denoting individual level of need were tested. However, due to data limitations with small sample sizes, the directions and magnitudes of the coefficients appeared inappropriate. Thus, we ended up using a binary indicator covering low to high levels of need (2 hours or more) in the middle school age group. We plan retesting individual indicators representing each level of need in special education when state-wide data are available. [↑](#footnote-ref-9)
10. Due to data limitations with smaller sample size, Targeted Title I was miniminally represented, so only school wide Title I is in model. [↑](#footnote-ref-10)
11. Originally multiple indicators of MEPA levels (Beginner, Early intermediate, Intermediate, Transiting to regular classes) were tested. However, due to small sample in individual MEPA levels with district data, final model aggregates MEPA levels beginner to intermediate as a single indicator, leaving transiting to regular classes and non-MEPA as 0 for this variable. The benefit of this strategy is that this indicator fits in the EWIS models with the current MEPA levels having 5 categories (Transiting to regular classes I and Transiting to regular classes II). Thus, the binary indicator of MEPA levels was used for the rest of EWIS models in middle and high school age groups. [↑](#footnote-ref-11)
12. Above proficient left out as reference category [↑](#footnote-ref-12)
13. Above proficient left out as reference category [↑](#footnote-ref-13)
14. Variables indicating whether a student did not enroll in or miss a certain subject (‘flagged’) were not tested in middle schools, because the numbers of students in falling in this category were too small (less than 2%) in middle schools [↑](#footnote-ref-14)
15. One districts sixth grade data was unable to be used due to data availability issues. [↑](#footnote-ref-15)
16. For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not passing all their grade 9 courses. [↑](#footnote-ref-16)
17. For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not passing all their grade 9 courses. [↑](#footnote-ref-17)
18. Because the attendance rate ranged from 0 to 1, the average estimated odds ratio for an increase of 0.1 point in the attendance rate is exp(-10.11×0.05)=0.60. This indicates that for every increase of 5% attendance rate, the risk of failing any course decreases 0.4 times (1-.0.60=0.40). [↑](#footnote-ref-18)
19. For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not passing all their grade 9 courses. [↑](#footnote-ref-19)
20. Students’ grade 12 data are not used, because the grade 12 risk level is determined based on grade 11 data. [↑](#footnote-ref-20)
21. Course taking and outcome data from seven districts were used to develop the state model. [↑](#footnote-ref-21)
22. For the tested cohort for grade 10 model, analysis does not include 8th grade ELA MCAS because the test was first administered in the 2005-06 school year and data were not available for 2004-5 year. For the 11th and 12th grade analysis, the 10th grade ELA and mathematics MCAS were tested. [↑](#footnote-ref-22)
23. The table includes all variables tested in the High School Age Group, but there may be variation in which of these were tested in individual grades. [↑](#footnote-ref-23)
24. Mobility was initially tested, but due to the course performance pilot, the variable was excluded. A large proportion of students who moved schools within the school year ended up lacking sufficient grade information and/or not being part of the outcome sample (by ninth grade they were not enrolled in a school that was taking part in the data pilot). This data point was considered different for this subgroup than the state as a whole. Retention is not included because the variable was directly related to the outcome benchmark in high schools, i.e., on-time graduation.  [↑](#footnote-ref-24)
25. This definition for overage is different than the ones used in other age groupings. [↑](#footnote-ref-25)
26. Specified urban areas are: Boston, Brockton, Cambridge, Chelsea, Chicopee, Everett, Fall River, Fitchburg, Framingham, Haverhill, Holyoke, Lawrence, Leominster, Lowell, Lynn, Malden, New Bedford, Pittsfield, Quincy, Revere, Somerville, Springfield, Taunton, Worcester; however, only *Brockton, Malden and New Bedford are used for this analyses*. These districts provided course taking and outcomes data for the analysis. [↑](#footnote-ref-26)
27. In the Early and Late Elementary Risk Models, targeted Title I was used as a variable. However, because of the limited sample size for the high school analysis, there were not enough students with this designation to conduct the analysis. This is a variable that should be explored once there is a full set of state level data available. [↑](#footnote-ref-27)
28. For the tested cohort for grade 10 model, analysis does not include 8th grade ELA MCAS because the test was not administered in the 2004-05 school year (when those students would have been expected to be in 8th grade). For the 11th and 12th grade analysis, the 10th grade [↑](#footnote-ref-28)
29. Above proficient left out as reference category [↑](#footnote-ref-29)
30. Students in the high school grades are only administered MCAS in 10th grade. MCAS results are part of the grade 10 model (using 8th grade MCAS results) and grade 11 (Using 10th grade MCAS results) risk determinations. ELA 8th grade MCAS was not available for necessary years. [↑](#footnote-ref-30)
31. Retention was not included in the high school model because this variable is directly related to the outcome measure, 4 years graduation, in the high school age group. [↑](#footnote-ref-31)
32. Grade 9 is not an MCAS tested year. Available MCAS data from grade 8 was used. ELA 8th grade MCAS was not available for necessary years. [↑](#footnote-ref-32)
33. For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not graduating on time. [↑](#footnote-ref-33)
34. Flagged as missing is a designation to identify students who did not take one of the core subjects (mathematics, English language arts, science, or social studies). “Flagged as missing mathematics” is not included there is multicollinearity problem with “flagged as missing ELA course” because most students who took ELA were highly likely to take Math as well in 9th and 10th grades. Unlike the high school age group, these variables were not included in the middle age group analyses, because the sample sizes per each cell were too small to be tested. [↑](#footnote-ref-34)
35. Because the attendance rate ranged from 0 to 1, the average estimated odds ratio for an increase of 0.1 point in the attendance rate is exp(-6.82 ×0.05)=0.71. This indicates that for every increase of 5% attendance rate, the risk of not graduating on time decreases a third (1-0.71). [↑](#footnote-ref-35)
36. For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not graduating on time. [↑](#footnote-ref-36)
37. Because the attendance rate ranged from 0 to 1, the average estimated odds ratio for an increase of 0.1 point in the attendance rate is exp(-8.42×0.05)=0.66. This indicates that for every increase of 5% attendance rate, the risk of not graduating on time decreases a third (1-0.66). [↑](#footnote-ref-37)
38. For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not graduating on time. [↑](#footnote-ref-38)
39. Because the attendance rate ranged from 0 to 1, the average estimated odds ratio for an increase of 0.1 point in the attendance rate is exp(-7.70×0.05)=0.68. This indicates that for every increase of 5% attendance rate, the risk of not graduating on time decreases approximately a third (1-0.68). [↑](#footnote-ref-39)