

Massachusetts Early Warning Indicator System (EWIS)

Technical Descriptions of Risk Model Development: Early and Late Elementary Age Groupings (Grades 1-6)

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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 framework¹. 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,

¹ HGLM models were not be able to 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 whether to employ HGLM with late elementary models.

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 <i>(expected student outcomes for each age group)</i>
Early Elementary	Grades 1-3	Proficient or advanced on 3rd grade ELA MCAS
Late Elementary	Grades 4-6	Proficient or advanced on 6 th grade ELA and Mathematics MCAS
Middle Grades	Grades 7-9	Passing grades on all 9 th 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 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

² At the middle and high school grades a sample of districts provided student course taking and course performance data to develop the EWIS risk model. The sample for the middle and high school model development is therefore much smaller.

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

<i>Indicates that, based on data from last school year, the student is...</i>	
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 ‘Final’ 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 meet 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 EWIS model, by grade level

Age Group Outcome Variable Indicators Included in Risk Model	Grade Level											
	Early Elementary			Late Elementary			Middle School			High School		
	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		
	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th	11 th	12 th
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 highschool, 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 minimally 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%).

Early Elementary Age Group (First through Third Grade)

The Early Elementary Age Group encompasses first through third grade, using data from students during their kindergarten, first and second grade year. Within the age group indicators of risk were tested at each grade level based on the outcome variable of scoring proficient or higher on the Third Grade English Language Arts (ELA) of Massachusetts Comprehensive Assessment System (MCAS). The outcome variable is chosen as a proxy for reading by the end of third grade benchmark.

Potential Indicators

In the Early Elementary Age Group, the indicators tested included behavioral, demographic and other variables. 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). Last, other individual student variables are focused on characteristics related to the type of services the student receives. Exhibit Early Elementary.1 provides an overview and definition of the indicators by variable³.

Exhibit Early Elementary.1. Indicator Definitions, by Type

Type	Indicator	Definition	Corresponding Data Source
Outcome variables			
	Third Grade English Language Arts MCAS	Binary variable: 1= Proficient or above proficient; 0=Warning or needs improvement Indicates students who achieve a proficient (or higher) or below proficient score on the Third Grade ELA MCAS	MCAS 2010 data variable name: EPERF2
Behavioral variables			
	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 ⁴	Binary variable: Based on whether child is listed as same grade between two consecutive years 1=Retained; 0=Not retained	SIMS DOE016
	Mobility	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 variables			
	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
	Overage for grade	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	SIMS DOE006

³ The table includes all variables tested in the Early Elementary Age Group, but there may be variation in which of these were tested in individual grades. For example, ‘Kindergarten, full day’ was only tested for the first grade model.

⁴ Retention is defined from fall to fall.

Type	Indicator	Definition	Corresponding Data Source
		year; 0= Age of child is less than one year than expected grade level age (e.g. a student who is 8 as of September 1 st of their second grade year is overage).	
	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 ⁵ ; 0= Student does not live in one of the specified urban areas	SIMS DOE014
	ELL program	Binary variable: 1= sheltered English Immersion (SEI) or 2-way bilingual or other; 0 = opt out, no program	SIMS DOE026
	Special Education – Level of Need	Special Education – Multiple indicators <ul style="list-style-type: none"> • 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 variables			
	Title I participation	Binary variables: <ul style="list-style-type: none"> • Targeted Title I, Binary variable: 1= Any type of targeted Title I participation; 0= Not included in targeted Title I⁶ • School -wide Title I, Binary variable: 1= School-wide Title I; 0= Not school-wide Title I 	SIMS DOE020
	Kindergarten - Full day	Binary variable: 1 = either full-time kindergarten or full-time kindergarten, tuitioned; otherwise 0.	SIMS DOE016

Analysis Methods and Strategies

To identify the model that most accurately predicted risk of students who do not achieve proficiency on third grade ELA MCAS, multiple analyses were conducted. For prediction of the third grade ELA MCAS proficiency, a separate analysis was conducted in each grade to predict a risk level for students as they entered the next year: first grade (using students' kindergarten data), second grade (using students' grade 1 data), and third grade (using students' grade 2 data).

Developing the Risk Model by Grade

For the data analysis, we focused on the 2009-10 third grade cohort of students with valid ELA MCAS performance scores. SIMS data in 2006-07 through 2009-10 were analyzed to identify the predictive indicators in each grade (see Exhibit Early Elementary.2).

⁵ 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 were the urban districts during the years tested.

⁶ There is only one possible outcome per student for the Title I variable, so if they are elected as school-wide Title I they cannot be considered targeted and vice versa according to the data.

Exhibit EarlyElementary.2. Numbers of students and schools by data source

3rd grade Proficiency in ELA				
MCAS				
Source Data	Below Threshold	Proficient or Above	# Students	# Schools
3rd grade in 2009-10	26,234 (37%)	44,433 (63%)	70,667	1,105
Kindergarten in 2006-07 (used to create 1st grade model)	20,813 (35%)	38,655 (65%)	59,468*	1,094
Grade 1 in 2007-08 (used to create 2nd grade model)	23,487 (36%)	41,812 (64%)	65,299	1,136
Grade 2 in 2008-09 (used to create 3rd grade model)	25,062 (37%)	43,212 (63%)	68,274	1,107

* Denotes the number of kindergarten students in 2006-07 who tested third grade MCAS assessment in 2009-10 SIMS data, and 11,199 third grade students out of 70,667 (16.4%) in 2009-10 have missing information in 2006-07 SIMS kindergarten data.

The following strategies were employed in each grade level analysis.

- First, in order to build an efficient and accurate model for the EWIS, we 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 –
 - Student behavioral variables only⁷;
 - 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 and targeted Title I;
 - Multi-level logistic regression⁸ to account for the clustering of students within schools, and allowed the level-1 intercept to be random; and
 - Multi-level logistic regression models with random intercept and slope were also tested, which enabled to examine whether the associations between level-1 (student) indicators and the outcome measure (not achieving proficiency on third grade ELA MCAS) vary across schools.⁹

⁷ The analysis began with behavior variables because we wanted to identify variables that are mutable, as opposed to demographic variables that are related to who a student is, rather than the behaviors he or she exhibits.

⁸ The SAS GLIMMIX procedure was used for data analysis.

⁹ Attention was paid to whether and to what extent a random slope model actually helps substantially improve prediction of identifying at-risk students. Because the ultimate goal of the EWIS is to apply the fitted models to another student cohort data and to obtain the predictive risk levels for individual students in the upcoming year, development of viable and robust statistical models is important.

First Grade: Analysis Results and Predicted Risk Levels

For the first grade model, models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is most predictive of whether a rising first grade student is at risk of not meeting the academic goal of achieving a score that is proficient or higher on the third ELA MCAS (Exhibit Grade1.1).

Exhibit Grade1.1 Overview of First Grade Risk Indicators

Grade:	First Grade (using data from Kindergarteners)
Age Grouping:	Early elementary (1 st -3 rd grade)
Risk Indicators Tested:	<p>Behavioral variables</p> <ul style="list-style-type: none"> • Suspensions, fall • Suspensions, end of year • Attendance rate, fall • Attendance rate, end of year • Mobility (more than one school within the school year) <p>Demographic variables</p> <ul style="list-style-type: none"> • Low income household- Free lunch • Low income household- Reduced price lunch • Special education level variables (4 total) • ELL status • Immigration status • Gender • Urban residence • Overage for grade (age 6 or older by sept 1st of Kindergarten) <p>Other individual student variables</p> <ul style="list-style-type: none"> • Kindergarten, full day • School wide Title I • Targeted Title I
Academic Goal/ Outcome Variable¹⁰:	Proficient or higher on the third grade English language arts MCAS (proxy for reading by third grade)

NOTE: A total of 59,468 observations included this outcome variable for the final model. Approximately 65 percent were characterized as proficient or above, and the remaining 35 percent were less than proficient.

First Grade: Simple Logistics – Analysis of Individual Indicators

We first examined a number of behavioral, demographic, and other indicators 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 Grade1.2). This analysis was used to inform the construction of the risk models tested (Exhibit Grade1.3).

¹⁰ For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not being proficient or higher on the third grade ELA MCAS.

Exhibit Grade1.2. Simple Logistic Regression Overview, Grade 1

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
Demographic variables (Yes/No)					
Low income household- Free lunch	1.34	0.02	<.0001	0.0726	59,468
Low income household- Reduced price lunch	0.88	0.04	<.0001		
Special education					
Low level of need (less than 2 hours)	0.55	0.04	<.0001	0.0552	59,468
Low level of need (2 or more hours)	1.41	0.06	<.0001		
Moderate level of need	1.55	0.04	<.0001		
High level of need	2.72	0.09	<.0001		
ELL status	1.14	0.03	<.0001	0.0227	59,468
Immigration status†	0.44	0.06	<.0001	0.0008	59,468
Sex: Female	-0.39	0.02	<.0001	0.0084	59,468
Overage for grade	0.60	0.03	<.0001	0.0049	59,468
Urban residence	0.97	0.02	<.0001	0.0464	59,468
Suspension					
Suspensions, fall†	0.79	0.25	0.0014	0.0002	58,625
Suspensions, end of year	0.65	0.07	<.0001	0.0023	59,468
Attendance					
Attendance rate, fall†	-1.19	0.10	<.0001	0.0025	58,625
Attendance rate, end of year	-4.28	0.17	<.0001	0.0120	59,468
Mobility - Changed schools during school year (Yes/No)					
Full time Kindergarten (Yes/No) †	0.58	0.02	<.0001	0.0164	59,468
Title I participation (Yes/No)					
School-wide	1.04	0.02	<.0001	0.0515	59,468
Targeted	1.16	0.06	<.0001		

Exhibit Reads: students overage for grade are 0.6 higher in the log-odds of not being proficient in ELA MCAS than others.

†Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

First Grade: Risk Models Overview and Final Model

Several risk models were tested and additional predictive probability of the model was balanced with model complexity. Our findings from the examination are that the random intercept model is predictive and more complex models (e.g., random intercept and slope model¹¹) did not much add to the

¹¹ The percentage of students who were classified as “high risk” and actually did not meet the proficiency level on the third grade ELA MCAS was two percent higher in the random intercept and slope model than in the random intercept model. The difference appears trivial enough to select the more parsimonious model, i.e., a random intercept model. Furthermore, when the comparison was made for another age group, the difference was almost null (0.2 percent higher in a random intercept and slope model than in a random intercept model). Thus, the

predictive probability of the model and introduced unnecessary complexity to the risk model. Exhibit Grade1.3 provides an overview of four of these models. Model 4 is was the chosen First Grade model.

Exhibit Grade1.3. Overview of Findings by Model, Grade 1

Variable	Logistic Regression Analysis			Random Intercept Model ¹²
	Model 1	Model 2	Model 3	<i>Final model</i> Model 4
Behavioral variables				
Attendance, fall†	-0.17			
Attendance, end of year	-3.81***	-1.47***	-1.40***	-1.13***
Suspensions, fall†	-0.24			
Suspensions, end of year	0.58***	0.20***	0.20***	0.18***
Mobility, Changed schools by the end of year	0.70***	0.35***	0.35***	0.33***
Demographic variables				
Low income household- Free lunch		0.95***	0.90***	0.80***
Low income household- Reduced price lunch		0.59***	0.54***	0.47***
Special education status				
Low level of need (< 2 hours)		0.63***	0.62***	0.66***
Low level of need (≥2 hours)		1.22***	1.22***	1.25***
Moderate level of need		1.58***	1.58***	1.63***
High level of need		2.55***	2.56***	2.61***
ELL status		0.69***	0.63***	0.62***
Immigration status†		-0.30***		
Gender (Female)		-0.28***	-0.28***	-0.28***
Urban residence		0.41***	0.26***	0.33***
Overage for grade		0.19***	0.20***	0.22***
Other Indicators				
Kindergarten - Full day †			-0.03	
School wide Title I			0.27***	0.30***
Targeted Title I			0.91***	1.02***
r²	0.0166	0.1394	0.1424	n/a
Variance of school-level intercept (standard error)				0.2047(0.0144)

Exhibit Reads: students that are overage for grade are 0.19 higher in the log-odds of not being proficient in ELA MCAS than others, holding constant other variables in Model 2.

†Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

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

random intercept model was determined the preferred model and applied to all early elementary age group analyses.

¹² Continuous variables (attendance and suspensions) were grand-mean centered, and all binary variables were not centered.

Exhibit Grade1.4 provides the summary statistics for the final model (Model 4). The estimates in column 2 denote the expected difference in the log-odds of not being proficient in third grade ELA MCAS, holding constant other variables in the model. For example, students in low income households who are receiving free lunch are expected to score 0.80 points higher than other students in the log-odds of not being proficient in ELA MCAS, holding other variables constant. Additionally, based on the result of the statistically significant random intercept at the school level, we can infer that the likelihood of not being proficient in third grade ELA MCAS also depends on school membership, holding constant student-level characteristics. With the exception of attendance and gender variables, all other variables are statistically positively associated with the recoded outcome variable (not being proficient on the third grade ELA MCAS).

Exhibit Grade1.4. Final Model – Behavioral Variables, Demographic Variables, and Other Indicators – Random Intercept Model, Summary Statistics

Variable	Estimate	S.E.	Pr > t
Behavioral variables			
Attendance rate, end of year	-1.13	0.16	<.0001
Suspensions, end of year	0.18	0.06	0.0038
Mobility - Changed schools during school year	0.33	0.04	<.0001
Demographic variables			
Low income household- Free lunch	0.80	0.03	<.0001
Low income household- Reduced price lunch	0.47	0.04	<.0001
Special Education			
Low level of need (less than 2 hours)	0.66	0.05	<.0001
Low level of need (2 or more hours)	1.25	0.07	<.0001
Moderate level of need	1.63	0.05	<.0001
High level of need	2.61	0.09	<.0001
ELL Status	0.62	0.04	<.0001
Sex: Female	-0.28	0.02	<.0001
Urban residence	0.33	0.06	<.0001
Overage for grade	0.22	0.04	<.0001
Other variables			
School wide Title I	0.30	0.06	<.0001
Target Title I	1.02	0.07	<.0001

Variance of school-level intercept (standard error): 0.2047 (0.0144)
 Number of observations=59468

First Grade: Illustration of Levels of Risk and MCAS Outcomes Using the Final Model

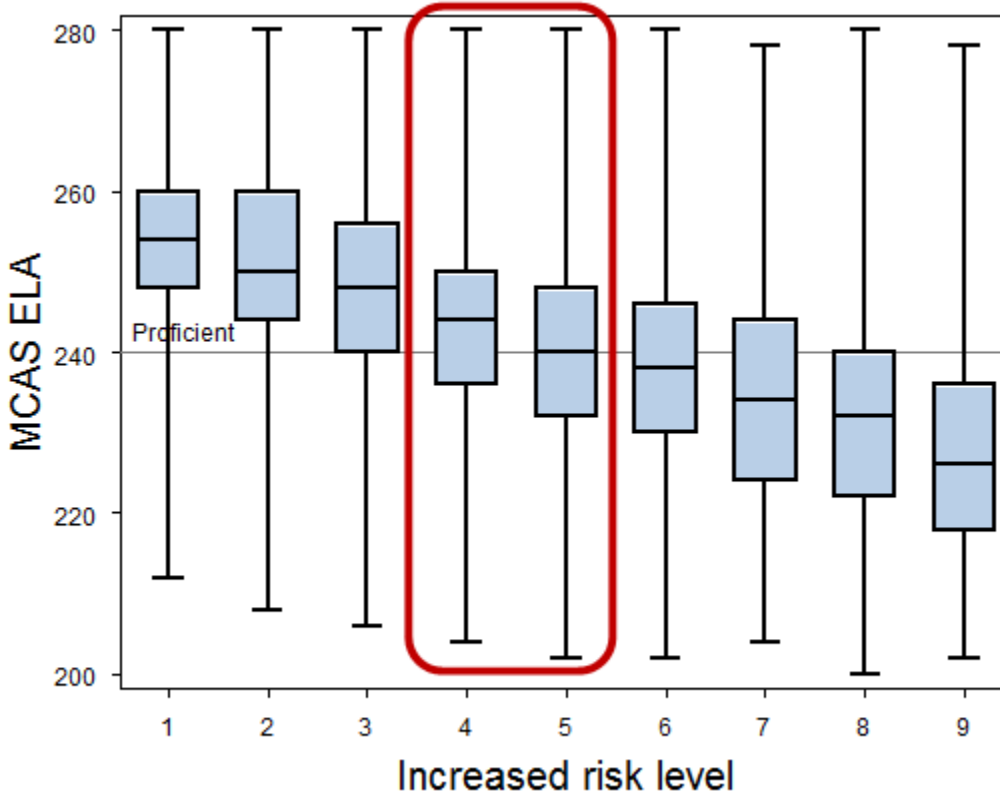
The following box plot shows the distribution of test scores by increased risk, using the First Grade EWIS Model. As the risk level increases (x axis), the proficiency level appears to decrease (y axis). The levels of risk are defined as follows:

- Low Risk (approximately 75% or more of students meet the outcome variable): Intervals 1-3;
- Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 4-5; and

- High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.¹³

Exhibit Grade1.5. Box Plot Distribution, Grade 1

First Grade Risk Based on Early Elementary Outcome: Proficient or Advanced on Grade 3 ELA MCAS



The statistics for the Final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade1.6 and Grade1.7. In summary, approximately 81 percent of students who fall into the low risk category have met the outcome variable of proficient or higher on the third grade ELA MCAS (Exhibit Grade1.7). Of the students who are categorized in the moderate risk category, approximately 60 percent of the students have met the outcome variable. Among the high risk students approximately 32 percent met the outcome variable and 68 percent of the students scored below proficient on the third Grade ELA MCAS.

¹³ In order to improve the prediction accuracy, a more stringent risk level threshold could have been employed; however, overidentification was preferred over underidentification in order to reduce the risk of excluding students in need of support or intervention.

Exhibit Grade1.6. Final Model – Risk Level Based on Box Plot Distribution, Grade 1

Total numbers of students in sample by risk levels

Increased risk level	Estimate For Probability of Risk	Frequency	Percent	Low risk	Moderate risk	High risk
1	< or = 0.1	420	0.71	420	0	0
2	< or = 0.2	15,069	25.34	15069	0	0
3	< or = 0.3	16,471	27.70	16471	0	0
4	< or = 0.4	8,571	14.41	0	8571	0
5	< or = 0.5	5,526	9.29	0	5526	0
6	< or = 0.6	5,041	8.48	0	0	5,041
7	< or = 0.7	3,842	6.46	0	0	3,842
8	< or = 0.8	2,381	4.00	0	0	2,381
9	>0.8	2,147	3.61	0	0	2,147
Total		59,468	100.0	31,960	14,097	13,411

Exhibit Grade1.7. Final Model - Predictive Probability of Proficiency Based on Risk Level, Grade 1

Predictive Probability of Proficiency Based on Risk Level			
Risk Level	Proficiency		Total
	Below Threshold	Proficient or Above	
Low	6,039 19%	25,921 81%	31,960 100%
Moderate	5,714 41%	8,383 59%	14,097 100%
High	9,060 68%	4,351 32%	13,411 100%
Total	20,813 35%	38,655 65%	59,468 100%

Second Grade: Analysis Results and Predicted Risk Levels

For second grade, several risk models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is predictive of whether a rising second grader is at risk of not meeting the academic goal of achieving a score that is proficient or above on the third grade English language arts Massachusetts Comprehensive Assessment System (ELA MCAS) based on their information from first grade (Exhibit Grade2.1).

Exhibit Grade2.1 Overview of Second Grade Risk Indicators

Grade:	2 (Using Data from grade 1 students)
Age Grouping:	Early elementary (1 st -3 rd grade)
Risk Indicators Tested:	Behavioral variables <ul style="list-style-type: none"> • Suspensions, end of year • Suspensions, fall semester • Attendance rate, end of year • Attendance rate, fall semester • Mobility (more than one school within the school year) • Retention Demographic variables <ul style="list-style-type: none"> • Low income household- Free lunch • Low income household- Reduced price lunch • Special education level variables (4 total) • ELL status • Immigration status • Gender • Urban residence • Overage for grade (age 7 or older by Sept 1st of 1st grade year) Other individual student variables <ul style="list-style-type: none"> • School wide Title I • Targeted Title I
Academic Goal/ Outcome Variable¹⁴:	Proficient or higher on the third grade English language arts MCAS (proxy for reading by third grade)

NOTE: A total of 65,299 observations included this outcome variable for the Final model. Approximately 65 percent were characterized as proficient or above, and the remaining 35 percent were less than proficient.

Second Grade: Simple Logistics – Analysis of Individual Indicators

In order to build the most efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, and other indicators 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 Grade2.2). This analysis was used to inform the construction of the risk models tested.

¹⁴ For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not being proficient or higher on the third grade ELA MCAS.

Exhibit Grade2.2. Simple Logistic Regression Overview, Grade 2

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
Demographic variables (Yes/No)					
Low income household- Free lunch	1.39	0.02	<.0001	0.0848	65,299
Low income household- Reduced price lunch	0.91	0.04	<.0001		
Special education					
Low level of need (less than 2 hours)	0.66	0.04	<.0001	0.0769	65,299
Low level of need (2 or more hours)	1.45	0.05	<.0001		
Moderate level of need	1.75	0.04	<.0001		
High level of need	2.86	0.08	<.0001		
ELL status	1.31	0.03	<.0001	0.0291	65,299
Immigration status [†]	0.58	0.06	<.0001	0.0016	65,299
Gender (Female)	-0.37	0.02	<.0001	0.0079	65,299
Overage for Grade	0.88	0.03	<.0001	0.0157	65,299
Urban residence	1.03	0.02	<.0001	0.0521	65,299
Suspension					
Suspensions, fall [†]	1.12	0.20	<.0001	0.0006	64,348
Suspensions, end of year	0.66	0.05	<.0001	0.0041	65,299
Attendance					
Attendance rate, fall [†]	-3.13	0.15	<.0001	0.0071	64,348
Attendance rate, end of year	-6.61	0.21	<.0001	0.0158	65,299
Mobility, Changed schools during school year (Yes/No)	0.83	0.04	<.0001	0.0067	65,299
Retained (Yes/No)	1.38	0.05	<.0001	0.0153	65,299
Other Variables					
Title I participation (Yes/No)					
School-wide	1.20	0.02	<.0001	0.0717	65,299
Targeted	1.17	0.04	<.0001		

Exhibit Reads: students who are overage in this model are 0.88 higher in the log-odds of not being proficient in ELA MCAS than others.

[†]Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

Second Grade: Overview Risk Models and Final Model

For exploratory purposes, the final model was further tested with and without school level characteristics. Two sources of data were used to comprehensively explore potential school-level characteristics: 1) student-level data in SIMS were aggregated to obtain various characteristics describing the set of first grade students in each school, and 2) NCES Common Core of Data (CCD): School Year 2007-08 were also used. In the final model, three school-level variables were included in: 1) the average attendance rate of students in grade 1; 2) the proportion of students who were eligible for free or reduced lunch at all grades; and 3) the proportion of African American students at all grades in each school. Other SIM-based aggregate variables were not statistically significant (i.e., the rate of retained students in grade 1, the rate of students in grade 1 who needed special education services, the rate of students receiving ELL programs in grade 1, the average number of days of suspension (in and out of school suspension). Furthermore, several school-level variables from CCD (regular schools vs. other types of school), a charter school indicator, the proportion of Hispanic students at all grades, and the calculated pupil/teacher ratio) from the CCD data were tested and none of them were statistically significant. When the comparison was made in predictive probability of proficiency by risk level between the random intercept models with and without the school-level characteristics, the percentages and numbers of students who scored below the proficiency thresholds based on the assigned risk levels were almost identical (17 percent vs. 18 percent among students classified as 'low risk'; 40 percent in both models among students classified as 'moderate risk'; and 70 percent in both models among the students classified as 'high risk'). Thus, the rest of analyses for the early elementary uses a random intercept model without school-level characteristics.

Exhibit Grade2.3 provides an overview of our final model for Grade 2 using summary statistics of the analysis. To produce the predicted values of the probability of not achieving proficient in 3rd grade ELA MCAS, the random effects at the school-level were accounted for, and thus the predicted probabilities could be different depending on school membership, conditioning on the student-level characteristics. The estimates in column 2 denote the expected difference in the log-odds of not being proficient in third grade ELA MCAS, holding constant other variables in the model. For example, students from an urban residence are expected to score 0.42 points higher than other students in the log-odds of not being proficient in ELA MCAS, holding other variables constant. Additionally, based on the result of the statistically significant random intercept at the school level, we can infer that the likelihood of not being proficient in third grade ELA MCAS also depends on school membership, holding constant student-level characteristics. With the exception of attendance and gender variables, all other variables are statistically positively associated with the recoded outcome variable (not being proficient on the third grade ELA MCAS).

**Exhibit Grade2.3. Final Model – Behavioral Variables, Demographic Variables, and Other Indicators
Random Intercept Model, Summary Statistics**

Variable	Estimate	S.E.	Pr > t
Behavioral variables			
Attendance rate, end of year	-1.77	0.24	<.0001
Suspensions, end of year	0.11	0.04	0.0108
Mobility - Changed schools during school year	0.29	0.05	<.0001
Retention	0.43	0.06	<.0001
Demographic variables			
Low income household- Free lunch	0.75	0.03	<.0001
Low income household- Reduced price lunch	0.45	0.04	<.0001
Special Education			
Low level of need (less than 2 hours)	0.74	0.04	<.0001
Low level of need (2 or more hours)	1.38	0.06	<.0001
Moderate level of need	1.86	0.04	<.0001
High level of need	2.79	0.09	<.0001
ELL Status	0.80	0.04	<.0001
Sex: Female	-0.24	0.02	<.0001
Urban residence	0.42	0.06	<.0001
Overage for grade	0.20	0.04	<.0001
Other variables			
School wide Title I	0.39	0.06	<.0001
Target Title I	1.24	0.04	<.0001
Variance of school-level intercept (standard error): 0.2307(0.0155)			
Number of observations=65,299			

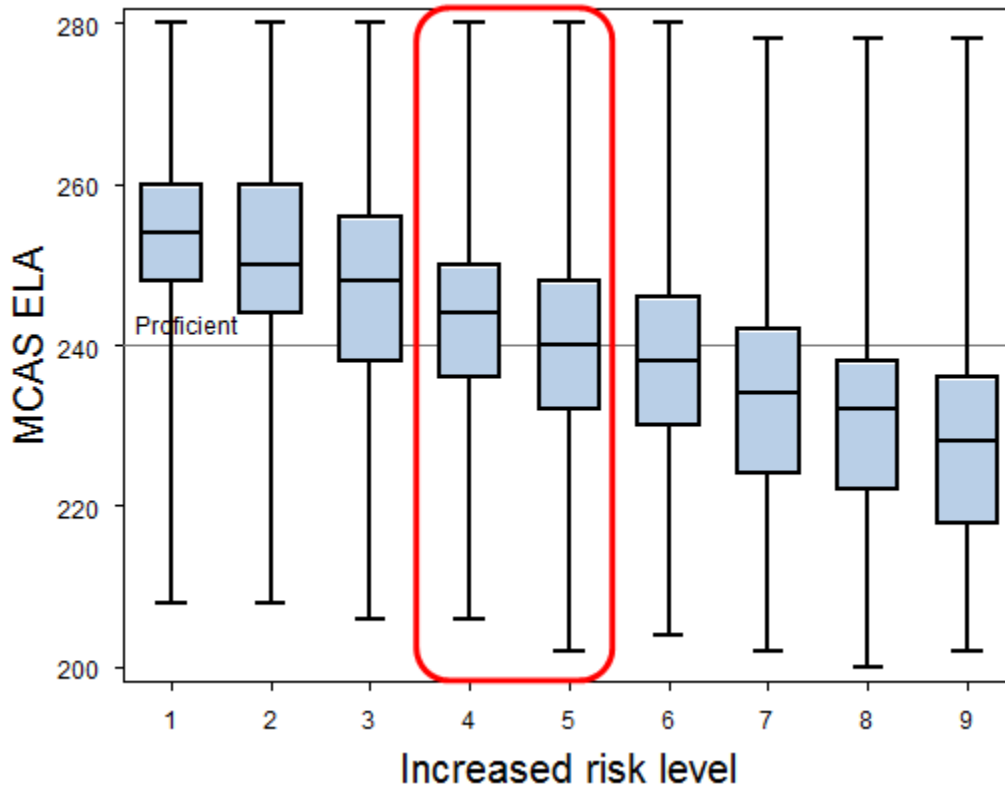
Second Grade: Illustration of Levels of Risk and MCAS Outcomes Using Final Model

The following box plot shows the distribution of test scores by increased risk, using the Final Model for second grade. As the risk level increases (x axis), the proficiency level appears to decrease (y axis). The levels of risk are defined as follows:

- Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-3;
- Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 4-5; and
- High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.¹⁵

¹⁵ In order to improve the prediction accuracy, a more stringent risk level threshold could have been employed; however, overidentification was preferred over underidentification in order to reduce the risk of excluding students in need of support or intervention.

**Exhibit Grade2.4. Final Model A - Box Plot Distribution, Grade 2
Second Grade Risk Based on Early Elementary Outcome: Proficient or Advanced on Grade 3 ELA MCAS**



The statistics for the final model for three levels of risk (low risk, moderate risk, and high risk) are shown in Exhibits Grade2.5 and Grade2.6. In summary, approximately 83 percent of students who fall into the low risk category have met the outcome variable of proficient or higher on the third grade ELA MCAS (Exhibit Grade2.7). Of the students who are categorized in the moderate risk category, approximately 59 percent of the students have met the outcome variable. Among the high risk students approximately 30 percent met the outcome variable and 68 percent of the students scored below proficient on the third Grade ELA MCAS.

Exhibit Grade2.5. Final Model – Risk Level Based on Box Plot Distribution, Grade 2

Total numbers of students in sample by risk levels

Increased risk level	Estimate For Probability of Risk	Frequency	Percent	Low risk	Moderate risk	High risk
1	< or = 0.1	1829	2.80	1829	0	0
2	< or = 0.2	19182	29.38	19182	0	0
3	< or = 0.3	13687	20.96	13687	0	0
4	< or = 0.4	7499	11.48	0	7499	0
5	< or = 0.5	5989	9.17	0	5989	0
6	< or = 0.6	5504	8.43	0	0	5504
7	< or = 0.7	4547	6.96	0	0	4547
8	< or = 0.8	3297	5.05	0	0	3297
9	>0.8	3765	5.77	0	0	3765
Total		65299	100.0	34698	13488	17113

Exhibit Grade2.6. Final Model- Predictive Probability of Proficiency Based on Risk Level, Grade 2

Predictive Probability of Proficiency Based on Risk Level			
Risk Level	Proficiency		Total
	Below Threshold	Proficient or Above	
Low	6,051 17%	28,647 83%	34,698
Moderate	5,466 41%	8,022 59%	13,488
High	11,370 70%	5,143 30%	17,113
Total	23,487 36%	41,812 64%	65,299 100%

Third Grade: Analysis Results and Predicted Risk Levels

For third grade, five models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is predictive of whether a rising third grade student is at risk of not meeting the outcome variable of achieving a score that is proficient or higher on the third grade ELA MCAS (Exhibit Grade3.1).

Exhibit Grade3.1 Overview of Third Grade Risk Indicators

Grade:	3 (Using data from grade 2 students)
Age Grouping:	Early elementary (1st -3rd grade)
Risk Indicators Tested:	Behavioral variables <ul style="list-style-type: none"> • Suspensions, end of year • Suspensions, Fall semester • Attendance rate, end of year • Attendance rate, Fall semester • Mobility (more than one school within the school year) • Retention Demographic variables <ul style="list-style-type: none"> • Low income household- Free lunch • Low income household- Reduced price lunch • Special education level variables (4 total) • ELL status • Immigration status • Gender • Urban residence • Overage for grade Other individual student variables <ul style="list-style-type: none"> • School wide Title I • Targeted Title I
Academic Goal/ Outcome Variable¹⁶:	Proficient or higher on the third grade English language arts MCAS (proxy for reading by third grade)

NOTE: A total of 68,274 observations included this outcome variable for the Final model. Approximately 63 percent were characterized as proficient or above, and the remaining 37 percent were less than proficient.

Third Grade: Simple Logistics – Analysis of Individual Indicators

In order to build the most efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, and other indicators 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 Grade3.2). This analysis was used to inform the construction of the risk models tested.

¹⁶ For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not being proficient or higher on the third grade ELA MCAS.

Exhibit Grade3.2. Simple Logistic Regression Overview, Grade 3

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
Demographic variables (Yes/No)					
Low income household- Free lunch	1.43	0.02	<.0001	0.0926	68,274
Low income household- Reduced price lunch	0.94	0.03	<.0001		
Special education					
Low level of need (less than 2 hours)	0.69	0.04	<.0001	0.0997	68,274
Low level of need (2 or more hours)	1.57	0.04	<.0001		
Moderate level of need	1.89	0.03	<.0001		
High level of need	2.87	0.07	<.0001		
ELL status	1.49	0.03	<.0001	0.0372	68,274
Immigration status [†]	0.75	0.05	<.0001	0.0029	68,274
Gender (Female)	-0.37	0.02	<.0001	0.0078	68,274
Overage for Grade	0.99	0.03	<.0001	0.0219	68,274
Urban residence	1.06	0.02	<.0001	0.0564	68,274
Suspension					
Suspensions, fall [†]	0.88	0.17	<.0001	0.0005	67,386
Suspensions, end of year	0.55	0.04	<.0001	0.0039	68,274
Attendance					
Attendance rate, fall [†]	-2.58	0.15	<.0001	0.0044	67,386
Attendance rate, end of year	-6.58	0.21	<.0001	0.0154	68,274
Mobility, Changed schools during school year (Yes/No)	0.83	0.04	<.0001	0.0068	68,274
Retained (Yes/No)	1.47	0.07	<.0001	0.0077	68,274
Other Variables					
Title I participation (Yes/No)					
School-wide	1.25	0.02	<.0001	0.0802	68,274
Targeted	1.33	0.03	<.0001		

Exhibit Reads: students who are overage when they were in second grade are 0.99 higher in the log-odds of not being proficient in ELA MCAS than others.

[†]Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

Third Grade: Overview of Final Model

Exhibit Grade3.3 provides an overview of our final model for third grade using summary statistics of the analysis. The estimates in column 2 denote the expected difference in the log-odds of not being proficient in third grade ELA MCAS, holding constant other variables in the model. For example, students who were retained in grade 2 are expected to score 0.25 points higher than other students in the log-odds of not being proficient in ELA MCAS, holding other variables constant. With the exception of attendance and gender variables, all other variables are statistically positively associated with the recoded outcome variable (not being proficient on the third grade ELA MCAS).

**Exhibit Grade3.3. Final Model – Behavioral Variables, Demographic Variables, and Other Indicators
Random Intercept Model, Grade 3**

Variable	Estimate	S.E.	Pr > t
Behavioral variables			
Attendance rate, end of year	-1.26	0.24	<.0001
Suspensions, end of year	0.03	0.04	0.4172
Mobility - Changed schools during school year	0.40	0.05	<.0001
Retention	0.25	0.08	0.0023
Demographic variables			
Low income household- Free lunch	0.76	0.03	<.0001
Low income household- Reduced price lunch	0.47	0.04	<.0001
Special Education			
Low level of need (less than 2 hours)	0.83	0.04	<.0001
Low level of need (2 or more hours)	1.57	0.05	<.0001
Moderate level of need	2.04	0.04	<.0001
High level of need	2.83	0.08	<.0001
ELL Status	1.02	0.04	<.0001
Sex: Female	-0.22	0.02	<.0001
Urban residence	0.45	0.06	<.0001
Overage for grade	0.30	0.03	<.0001
Other variables			
School wide Title I	0.38	0.06	<.0001
Target Title I	1.42	0.04	<.0001

Variance of school-level intercept (standard error): 0.2620(0.0166)

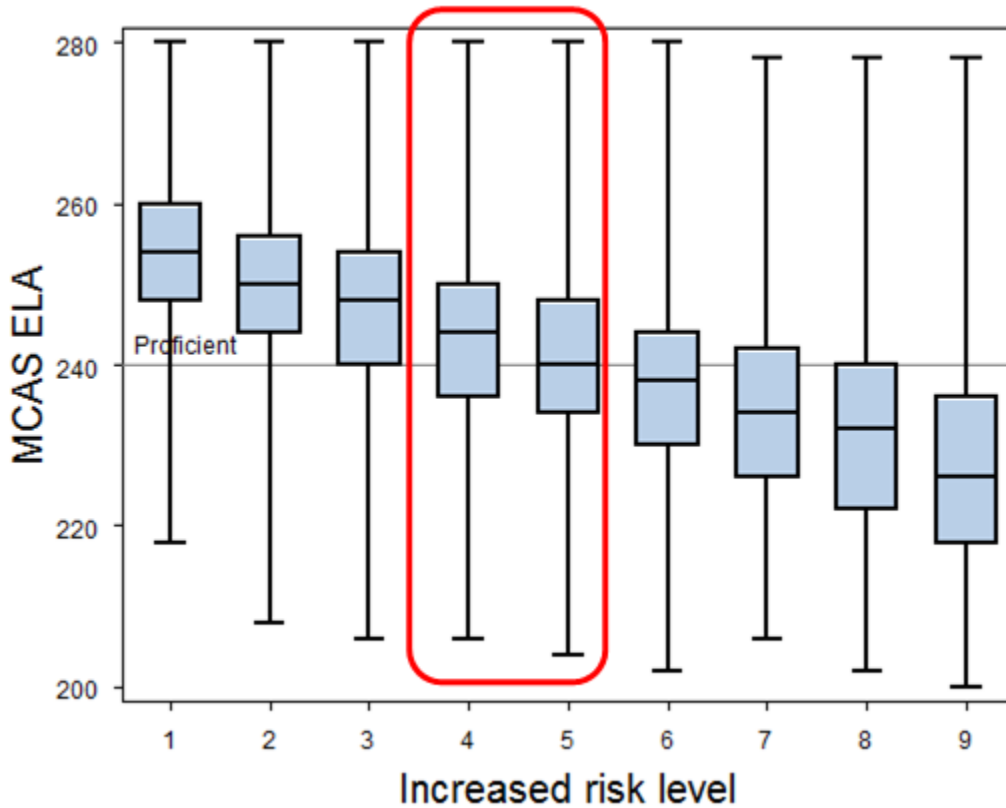
Number of observations=68274

Third Grade: Illustration of Levels of Risk and MCAS Outcomes Using Final Model

The following box plot shows the distribution of test scores by increased risk, using the Final model. As the risk level increases (x axis), the proficiency level appears to decrease (y axis). The levels of risk are defined as follows:

- Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-3;
- Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 4-5; and
- High Risk (approximately a third or less of the students meet the outcome variable): Intervals 6-9.

**Exhibit Grade3.4. Final Model A - Box Plot Distribution, Grade 3
Third Grade Risk Based on Early Elementary Outcome: Proficient or Advanced on Grade 3 ELA MCAS**



The statistics for the Final model’s three levels of risk (low risk; moderate risk and high risk_ are shown in Exhibits Grade3.5 and Grade3.6. In summary, approximately 84 percent of students who fell into the low risk category have met the outcome variable of proficient or higher on the third grade ELA MCAS (Exhibit Grade3.6). Of the students who were categorized in the moderate risk category, approximately 59 percent of the students have met the outcome variable. Among the high risk students approximately 28 percent met the outcome variable and 72 percent of the students scored below proficient on the third grade ELA MCAS.

Exhibit Grade3.5. Final Model – Risk Level Based on Box Plot Distribution, Grade 3

Total numbers of students in sample by risk levels

Increased risk level	Estimate For Probability of Risk	Frequency	Percent	Low risk	Moderate risk	High risk
1	< or = 0.1	3,680	5.39	3,680	0	0
2	< or = 0.2	20,167	29.54	20,167	0	0
3	< or = 0.3	12,503	18.31	12,503	0	0
4	< or = 0.4	6,624	9.70	0	6,624	0
5	< or = 0.5	5,919	8.67	0	5,919	0
6	< or = 0.6	5,365	7.86	0	0	5,365
7	< or = 0.7	4,673	6.84	0	0	4,673
8	< or = 0.8	3,875	5.68	0	0	3,875
9	>0.8	5,468	8.01	0	0	5,468
Total		68,274	100.0	36,350	12,543	19,381

Exhibit Grade3.6. Final Model- Predictive Probability of Proficiency Based on Risk Level, Grade 3

Predictive Probability of Proficiency Based on Risk Level			
Risk Level	Proficiency		Total
	Below Threshold	Proficient or Above	
Low	5,938 16%	30,412 84%	36,350
Moderate	5,123 41%	7,420 59%	12,543
High	14,001 72%	5,380 28%	19,381
Total	25,062 37%	43,212 63%	68,274 100%

Early Elementary Risk Model Validation: Comparison of 2008-09 to 2009-10 Cohort

In order to show the strength of the Final model in other cohorts, the following exhibits show the extent to which the developed risk model using the 2009-10 cohort data correctly identifies at-risk students in the 2008-09 cohort.

As shown in Exhibit Early Elementary Validation.1, while there are general similarities in the predictive probability of the model between the original and the validation cohorts, there is some difference in predictive probability at different grade levels. In looking closely at Grade 2 and Grade 3, the validation cohort (2008-09 school year) has a slightly higher percentage of children deemed 'low risk' who are not reaching proficient levels than the original cohort (23% vs. 17%). Also, the percentage of children identified as 'moderate risk' who fall below the threshold in the validation cohort is slightly higher than the percentage in the original cohort (48% vs. 41%). This may signal that the validity of the EWIS model for prediction could depend on the degree of the cohort variation from year to year. EWIS validations will be done annually, and the model adjusted if needed.

Exhibit Early Elementary Validation.2 shows the finalized risk model and the validation output from the model for grades 1 through 3, using the 2009-10 cohort and our validation cohort (2008-09). As the exhibit shows, the coefficients are fairly similar in magnitude and significance, and the directions of the coefficients are the same between the models. The consistency of the coefficients between cohorts implies that the selected indicators are behaving similarly in reference to our outcome variable in different groups.

Exhibit Early Elementary Validation.1 Predictive Probability of Proficiency Original Cohort vs. Validation Cohort, Grades 1-3

Predictive Probability of Proficiency Based on Risk Level FIRST GRADE				
Risk Level	Below Threshold		Proficient or Above	
	2009-10 cohort	2008-09 cohort	2009-10 cohort	2008-09 cohort
Low	6,039 18.90%	6,051 23.28%	25,921 81.10%	19,942 76.72%
Moderate	5,714 40.53%	6,878 39.83%	8,383 59.47%	10,389 60.17%
High	9,060 67.56%	10,828 68.89%	4,351 32.44%	4,889 31.11%
Total	20,813 35.00%	23,757 40.28%	38,655 65.00%	35,220 59.72%

Predictive Probability of Proficiency Based on Risk Level SECOND GRADE				
Risk Level	Below Threshold		Proficient or Above	
	2009-10 cohort	2008-09 cohort	2009-10 cohort	2008-09 cohort
Low	6,051 17.44%	8,045 23.04%	28,647 82.56%	26,878 76.96%
Moderate	5,466 40.52%	6,422 48.02%	8,022 59.48%	6,952 51.98%
High	11,970 69.95%	12,371 73.75%	5,143 30.05%	4,404 26.25%
Total	23,487 35.97%	26,838 41.24%	41,812 64.03%	38,234 58.76%

Predictive Probability of Proficiency Based on Risk Level THIRD GRADE				
Risk Level	Below Threshold		Proficient or Above	
	2009-10 cohort	2008-09 cohort	2009-10 cohort	2008-09 cohort
Low	5,938 16.34%	8,141 21.96%	30,412 83.66%	28,937 78.04%
Moderate	5,123 40.84%	6,251 50.30%	7,420 59.16%	6,177 49.70%
High	14,001 72.24%	14,097 76.23%	5,380 27.76%	4,396 23.77%
Total	25,062 36.71%	28,489 41.90%	43,212 63.29%	39,510 58.10%

Exhibit Early Elementary Validation.2. Overview of Findings by Cohort Using Final Model, Grade1-3

Variable	Grade 1		Grade 2		Grade 3	
	Original Cohort (2009-10)	Validation Cohort (2008-09)	Original Cohort (2009-10)	Validation Cohort (2008-09)	Original Cohort (2009-10)	Validation Cohort (2008-09)
Behavioral variables						
Attendance rate, end of year	-1.13***	-1.37***	-1.77***	-1.06***	-1.26***	-2.29***
Suspensions, end of year	0.18**	0.22**	0.11**	0.14**	0.03	0.14**
Mobility - Changed schools during school year	0.33***	0.26***	0.29***	0.42***	0.40***	0.50***
Retention	-	-	0.43***	0.37***	0.25**	0.34***
Demographic variables						
Low income household- Free lunch	0.80***	0.90***	0.75***	0.88***	0.76***	0.84***
Low income household- Reduced price lunch	0.47***	0.61***	0.45***	0.57***	0.47***	0.60***
Special Education						
Low level of need (less than 2 hours)	0.66***	0.72***	0.74***	0.76***	0.83***	0.99***
Low level of need (2 or more hours)	1.25***	1.32***	1.38***	1.52***	1.57***	1.61***
Moderate level of need	1.63***	1.65***	1.86***	1.81***	2.04***	1.99***
High level of need	2.61***	2.35***	2.79***	2.53***	2.83***	2.56***
ELL Status	0.62***	0.56***	0.80***	0.66***	1.02***	0.96***
Sex: Female	-0.28***	-0.17***	-0.24***	-0.13***	-0.22***	-0.11***
Urban residence	0.33***	0.37***	0.42***	0.44***	0.45***	0.50***
Overage for grade	0.22***	-0.12*	0.20***	0.24***	0.30***	0.29***
Other variables						
School wide Title I	0.30***	0.29***	0.39***	0.35***	0.38***	0.39***
Target Title I	1.02***	0.98***	1.24***	1.24***	1.42***	1.54***

Significant at 10%, **Significant at 5%, ***Significant at 1%
 - variable not included in model

Late Elementary Age Group (Fourth through Sixth Grade)

The Late Elementary Age Group encompasses fourth through sixth grade, using data from third, fourth and fifth graders. Within the age group indicators of risk were tested at each grade level based on the outcome variable of scoring proficient or higher on a combined proficiency of 6th Grade English Language Arts MCAS and 6th Grade Math MCAS.

Potential Indicators

In the Late Elementary Age Group, the indicators tested included behavioral, demographic, other variables, and the MEPA levels and proficiency in both ELA and math MCAS. 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 late elementary analysis brings in skill assessments using MEPA levels and math and English MCAS proficiency levels, which results in substantial improvement of prediction accuracy. *Exhibit Late Elementary.1* provides a summary of the indicators that were tested in the late elementary grades.¹⁷

Exhibit Late Elementary.1. Indicator Definitions, by Type

Type	Indicator	Definition	Corresponding Data Source
Outcome Variable			
	Sixth Grade English Language Arts and Math MCAS	Binary variable: 1= Proficient or above proficient in both Math and English; 0=Warning or needs improvement in <i>either</i> Math or English Indicates students who achieve a proficient (or higher) or below proficient score on the Sixth Grade ELA and Math MCAS	MCAS 2010 data variable name: EPERF2 MPERF2
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 ¹⁸	Binary variable: Based on whether child is listed as grade 1 status in both 2007 and 2008 Fall data 1=Retained; 0=Not retained	SIMS DOE016
	Mobility	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	Binary variable: 1=Free lunch eligible; 0= not eligible	SIMS DOE019

¹⁷ The table includes all variables tested in the Late Elementary Age Group, but there may be variation in which of these were tested in individual grades.

¹⁸ Retention is defined from fall to fall.

Type	Indicator	Definition	Corresponding Data Source
	lunch		
	Low income household – Reduced price lunch	Binary variable: 1=Reduced lunch recipient; 0= Not eligible for reduced price lunch	SIMS DOE019
	Former LEP	Binary variable: 1= Former LEP student; 0=Current or no LEP status	e.g., MCAS 2008 data variable for 2008-09 cohort data name: LEPFLEP_OFF minus LEP_OFF
	ELL program	Binary variable: 1= sheltered English Immersion (SEI) or 2-way bilingual or other; 0 = opt out, no program	SIMS DOE014
	Overage for grade	Binary variable: 1=Age of child is equal to or greater than one year expected grade level age as of September 1 in a given calendar year; 0= Age of child is less than one year more than expected grade level age (e.g. a student 10 or older on September 1 st of their 4 th grade year is overage)	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 ¹⁹ ; 0= Student does not live in one of the specified urban areas	SIMS DOE014
	Special Education – Level of Need	Special Education – Multiple indicators <ul style="list-style-type: none"> • 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	Binary variables: <ul style="list-style-type: none"> • Targeted Title I, Binary variable: 1= Any type of targeted Title I participation; 0= Not included in targeted Title I²⁰ • School -wide Title I, Binary variable: 1= School-wide Title I; 0= Not school-wide Title I 	SIMS DOE020

¹⁹ 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. This reflects urban areas for years tested.

²⁰ There is only one possible outcome per student for the Title I variable, so if they are elected as school-wide Title I they cannot be considered targeted and vice versa according to the data.

MEPA Levels		
Massachusetts English Proficiency Assessment (MEPA)	Binary variable: <ul style="list-style-type: none"> • Beginner level to Intermediate level is equal to 1; otherwise 0.²¹ 	MEAP Spring 2008 data variable name: pl
MCAS Proficiency Levels		
MCAS Proficiency levels in Math and English	Multiple indicators <ul style="list-style-type: none"> • Math²² <ul style="list-style-type: none"> ○ 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. • English²³ <ul style="list-style-type: none"> ○ 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. 	e.g., MCAS 2008 data variable for 2008-09 cohort data name: EPERF2 MPERF2

Analysis Methods and Strategies

To identify the model that most accurately predicts risk of not achieving proficiency on sixth grade ELA and Mathematics MCAS, we conducted multiple analyses. For prediction of the sixth grade ELA and math MCAS proficiency, a separate analysis was conducted in each grade taking into account the students information from the previous year to provide a risk level for students as they enter the next year : fourth grade (using students’ grade 3 data), fifth grade (using students’ grade 4 data) and sixth grade (using students’ grade 5 data).

For data analysis, we focused on 2009-10 sixth grade cohort that include students with valid sixth grade ELA and math MCAS performance scores, and SIMS data in 2006-07 through 2009-10 were analyzed to identify the predictive indicators in each grade (see Exhibit Late Elementary.2).

²¹ 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. -

²² Above proficient left out as reference category

²³ Above proficient left out as reference category

Exhibit Late Elementary.2. Numbers of students and schools by data source

6th grade Proficiency in both ELA & Math MCAS

Source Data	Warning or needs improvement in either Math or English	Proficient or Above in ELA and Math	# Students
Grade 6 in 2009-10	33,186 (46%)	38,757 (54%)	71,943
Grade 3 in 2006-07 (used to create 4 th grade model)	29,249 (45%)	36,248 (55%)	65,497
Grade 4 in 2007-08 (used to create 5 th grade model)	28,830 (44%)	35,960 (56%)	64,790
Grade 5 in 2008-09 (used to create 6 th grade model)	29,847 (45%)	36,747 (55%)	66,594

The following strategies were employed in grade level 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 –
 - 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 and targeted Title I;
 - Demographic variables, behavioral variables, individual student variables including the availability of school wide and targeted Title I, and MEPA levels;
 - Demographic variables, behavioral variables, and individual student variables including the availability of school wide and targeted Title I, MEPA levels, and MCAS proficiency levels.

Additionally, multi-level logistic regression, to account for the clustering of students within schools, and allowed the level-1 intercept to be random, was tested for grade 5 and 6 models. The EWIS models were able to be updated to use more recent MCAS scores than MCAS data used in model testing by AIR. Due to time constraints and issues with transferring the statistical syntax, ESE made the decision to update the most predictive logistical regressions with the more recent MCAS scores than use multi-level logistical regression with older data. Future iterations of the late elementary models may utilize multi-level logistical regression.

Additionally, the model created using information for the third grade year was initially part of the early elementary model with the outcome for being proficient or advanced for on the grade 3 ELA MCAS. In order for this predictive model to be of value, it was built using fall indicators and would provide a mid-year indicator for students so it could be provided to educators before those students took their grade 3

MCAS (the outcome event). Upon further reflection, ESE decided to use the full year of third grade student information to create EWIS model and designate risk levels for rising fourth grade students tied to the Late Elementary Model Outcome, Proficient or Advanced on the grade 6 ELA and Math MCAS. Therefore, the model for fifth grade and sixth grade were finalized before the model for fourth grade was finalized. Testing for possible interaction terms were done for the later grades and are discussed in those sections.

Fourth Grade: Analysis Results and Predicted Risk Levels

In fourth grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is predictive of whether a rising fourth grade student is at risk of not meeting the academic goal of achieving a score that is proficient or higher on both the sixth grade English language arts (ELA) and Math Massachusetts Comprehensive Assessment System (MCAS) (Exhibit Grade4.1).

Exhibit Grade4.1 Overview of Fourth Grade Risk Indicators

Grade:	4 (using data form Grade 3)
Age Grouping:	Late elementary (4 th thru 6 th grade)
Risk Indicators Tested:	<ul style="list-style-type: none"> Behavioral variables <ul style="list-style-type: none"> • Suspensions, fall • Suspensions, end of year • Attendance rate, fall • Attendance rate, end of year • Mobility (more than one school within the school year) • Retention Demographic variables <ul style="list-style-type: none"> • Low income household- Free lunch • Low income household- Reduced price lunch • Special education level variables (4 total) • ELL status • Former LEP • Immigration status • Gender • Urban residence • Overage for grade (9 or older as of Sept 1 of 3rd grade year) Other individual student variables <ul style="list-style-type: none"> • School wide Title I • Targeted Title I MEPA levels²⁴ <ul style="list-style-type: none"> • Low Levels 3rd Grade MCAS Proficiency Levels <ul style="list-style-type: none"> • Math <ul style="list-style-type: none"> ○ Warning ○ Needs Improvement ○ Proficient • English <ul style="list-style-type: none"> ○ Warning ○ Needs Improvement ○ Proficient
Academic Goal/ Outcome Variable:²⁵	Proficient or higher on the sixth grade ELA <i>and</i> Math MCAS; Not proficient on either is equal to zero for this outcome

NOTE: A total of 62,774 observations included this outcome variable for the final model. Approximately 56 percent were characterized as proficient or advanced on both the ELA and Math MCAS, and the remaining 44 percent were less than proficient.

²⁴ Due to small sample in individual MEPA levels, final model aggregates MEPA levels beginner to intermediate as a single indicator, leaving transitioning to regular classes and non-MEPA as 0 for this variable.

²⁵ For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not being proficient or higher on the sixth third grade ELA and/or Math MCAS.

Fourth Grade: Simple Logistics – Analysis of Individual Indicators

In order to build the most efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, and other indicators from the Fall semester 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 Grade4.2). This analysis was used to inform the construction of the risk models tested.

Exhibit Grade4.2. Simple Logistic Regression Overview, Grade 4

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
Demographic variables (Yes/No)					
Low income household- Free lunch	1.57	0.02	<.0001	0.103	65,497
Low income household- Reduced price lunch	0.99	0.03	<.0001		
Special education					
Low level of need (less than 2 hours)	.965	0.05	<.0001	0.121	65,497
Low level of need (2 or more hours)	1.81	0.05	<.0001		
Moderate level of need	2.13	0.04	<.0001		
High level of need	3.37	0.10	<.0001		
Immigration status [†]	0.37	0.05	<.0001	0.001	65,497
Sex: Female	-0.28	0.02	<.0001	0.003	65,497
ELL status †	1.15	0.04	<.0001	0.017	65,497
Former LEP student [†]	0.30	0.05	<.0001	0.001	65,497
Overage for grade	1.30	0.03	<.0001	0.040	65,497
Urban residence	1.06	0.02	<.0001	0.056	65,497
Suspension					
Suspensions, fall [†]	1.14	0.21	<.0001	0.001	65,497
Suspensions, end of year	1.10	0.06	<.0001	0.010	65,497
Attendance					
Attendance rate, fall [†]	-3.68	0.17	<.0001	0.009	65,497
Attendance rate, end of year	-9.65	0.25	<.0001	0.026	65,497
Mobility - Changed schools during school year (Y/N)	1.05	0.04	<.0001	0.010	65,497
Retained (Yes/No) †	1.95	0.11	<.0001	0.008	65,497
Title I participation (Yes/No)					
School-wide	1.28	0.02	<.0001	0.086	65,497
Targeted	1.54	0.04	<.0001		
MEPA Levels (Yes/No)					
Low level	2.17	0.06	<.0001	0.027	65,497
3rd Grade MCAS Proficiency Levels					
MATH					
Warning	5.72	0.06	<.0001	0.351	65,497
Needs Improvement	3.57	0.04	<.0001		
Proficient	1.79	0.04	<.0001		
ENGLISH					
Warning	5.84	0.08	<.0001	0.306	65,497
Needs Improvement	3.74	0.05	<.0001		
Proficient	1.80	0.05	<.0001		

[†]Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

Fourth Grade Overview of Risk Models and Final Model

Several risk models were tested and additional predictive probability of the model was balanced with model complexity. Several external factors as described in the previous section influenced the final model for this grade level. Exhibit Grade4.3 provides an overview of five of these models. Model 5 is the final Fourth grade EWIS model.

Exhibit Grade 4.3. Overview of Findings by Model, Grade 4

Variable	Logistic Regression Analysis				
	Model 1	Model 2	Model 3	Model 4	Final Model Model 5
Behavioral variables					
Attendance, Fall†	-1.15***				
Attendance, end of year	-8.29***	-5.54***	-5.55***	-5.57***	-3.96***
Suspensions, Fall†	0.15				
Suspensions, end of year	0.93***	0.39***	0.37***	0.37***	0.21***
Mobility, Changed schools by the end of year	.933***	0.45***	0.46***	0.45***	0.16**
Retention†	1.81***	0.55***	0.52***	0.51***	.48***
Demographic variables					
Low income household- Free lunch		1.11***	0.98***	0.97***	0.52***
Low income household- Reduced price lunch		0.78***	0.67***	0.67***	0.35***
Special education status					
Low level of need (less than 2 hours)		1.09***	1.07***	1.07***	0.59***
Low level of need (2 or more hours)		1.72***	1.700***	1.70***	0.95***
Moderate level of need		2.09***	2.13***	2.12***	1.11***
High level of need		3.09***	3.11***	3.12***	1.75***
ELL Status†		0.43***	0.31***	-0.14*	
Former LEP†		-0.22**			
Immigration status†		-0.37**			
Sex: Female		-0.02	-0.03	-0.02	-0.14***
Urban residence		0.47***	0.25***	0.25***	0.03
Overage for grade		0.57***	0.55***	0.54***	0.42***
Other Indicators					
School wide Title I			0.57***	0.49***	0.36***
Targeted Title I			1.50***	1.50***	0.65***
MEPA Levels²⁶ (Yes/No)					
Low Level				1.31***	.12*
3rd Grade MCAS Proficiency Levels					
MATH					
Warning					3.79***
Needs Improvement					2.45***
Proficient					1.24***
ENGLISH					
Warning					2.71***
Needs Improvement					2.01***
Proficient					1.04***
r ²	0.043	0.223	0.241	0.245	0.424

²⁶ Due to small sample sizes in categories, final model groups beginning to intermediate levels into one category, leaving transitioning to regular classes and non-MEPA as the reference group.

Exhibit Grade4.4 provides an overview of our Final model for Grade 4 using summary statistics of the analysis. The estimates in column 2 denote the expected difference in the log-odds of not being proficient in third grade ELA MCAS, holding constant other variables in the model. With the exception of attendance and gender variables, all other variables are statistically positively associated with the recoded outcome variable (not being proficient on the third grade ELA MCAS). For example, students who were overage for their grade are expected to score 0.42 points higher than other students in the log-odds of not being proficient on the sixth grade Math and ELA MCAS, holding other variables constant.

Exhibit Grade4.4. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, and MCAS

Variable	Estimate	S.E.	Pr > t
Behavioral variables			
Attendance rate, end of year	-3.96	0.35	<.0001
Suspensions, end of year	0.21	0.06	<.0001
Mobility - Changed schools during school year	0.16	0.07	0.025
Demographic variables			
Low income household- Free lunch	0.52	0.07	<.0001
Low income household- Reduced price lunch	0.35	0.05	<.0001
Special Education			
Low level of need (less than 2 hours)	0.59	0.06	<.0001
Low level of need (2 or more hours)	0.95	0.06	<.0001
Moderate level of need	1.11	0.05	<.0001
High level of need	1.75	0.13	<.0001
Sex: Female	-0.14	0.02	<.0001
Urban residence	0.03	0.02	0.4
Overage for grade	0.42	0.04	<.0001
Other variables			
School wide Title I	0.12	0.09	<.0001
Target Title I	0.65	0.05	<.0001
MEPA Levels			
Low level (Beginner to intermediate)	0.12	0.01	0.01
3 rd Grade MCAS Proficiency Levels			
MATH			
Warning	3.79	0.07	<.0001
Needs Improvement	2.45	0.05	<.0001
Proficient	1.24	0.04	<.0001
ENGLISH			
Warning	2.71	0.09	<.0001
Needs Improvement	2.01	0.05	<.0001
Proficient	1.04	0.05	<.0001

R²=0.424
Number of observations=62,774

Fourth Grade: Illustration of Levels of Risk and MCAS Outcomes Using Final Model

The following box plot shows the distribution of test scores by increased risk, using the Final Model. As the risk level increases (x axis), the proficiency level appears to decrease (y axis).

Exhibit Grade4.5. Final Model- Box Plot Distribution, Grade 4 Risk Level and 6th grade ELA MCAS

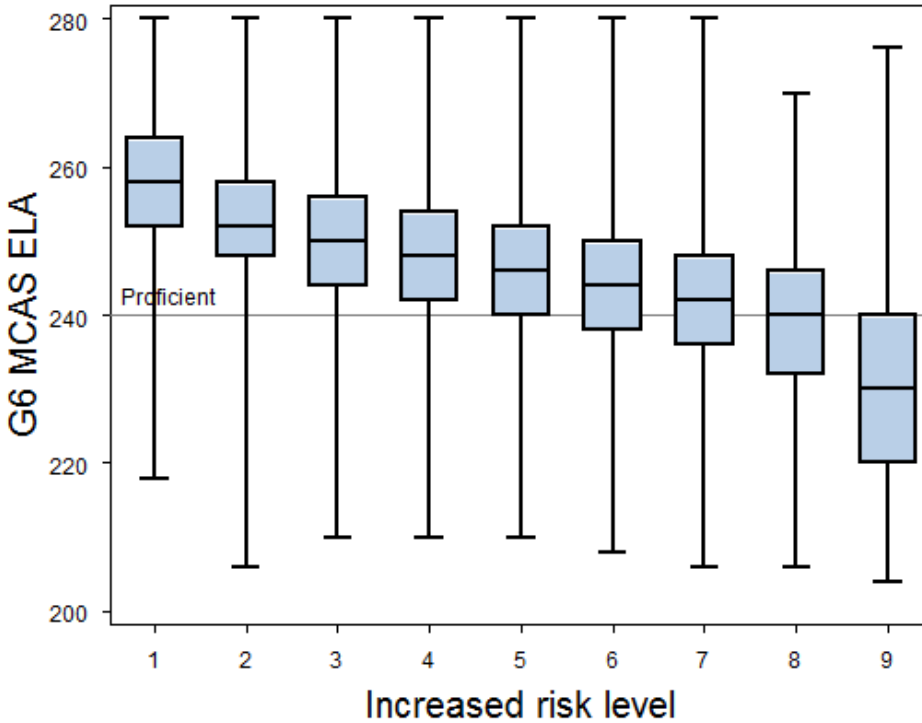
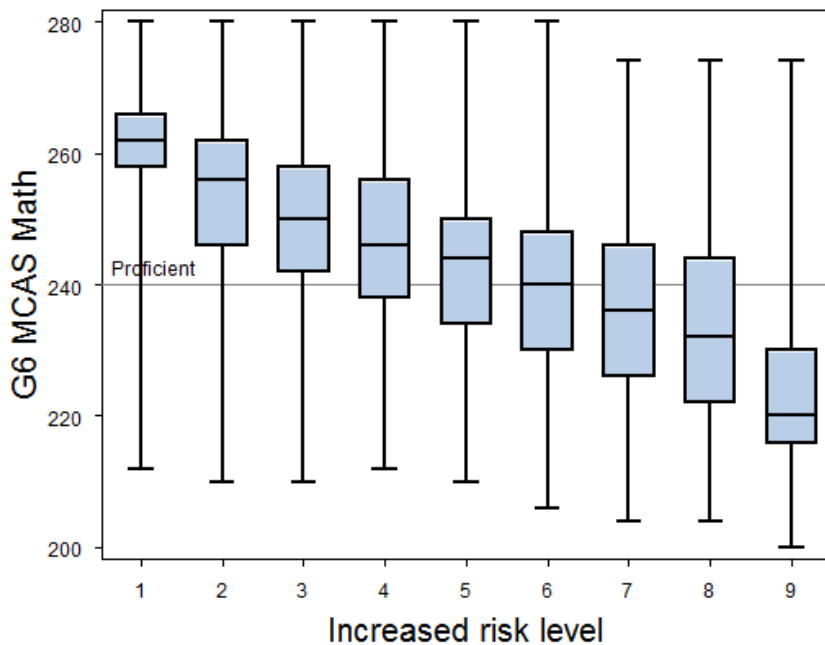


Exhibit Grade4.6. Final Model- Box Plot Distribution, Grade 4 Risk Level and 6th grade Math MCAS



Based on analysis, the levels of risk were defined as follows:

- Low Risk (approximately 75% or more of students meet the outcome variable): Intervals 1-3;
- Moderate Risk (approximately half or more than half of the students meet the outcome variable): Intervals 4-5; 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 Grade4.6 and Grade4.7. In summary, approximately 88 percent of students who fall into the low risk category have met or exceeded the proficiency level in both ELA and math on the grade 6 MCAS. Of the students who are categorized in the moderate risk category, approximately 55 percent of the students have met the outcome variable. Among the high risk students approximately 16 percent met the outcome variable and 84 percent of the students scored below proficient on the six grade proficiency in ELA and/or math.

Note that as assessment data (MCAS test scores) were included in the risk model, the prediction accuracy rates in the late elementary group analysis increased, and the actual numbers of students that were incorrectly identified (either students classified as ‘low risk’ who actually did not meet the threshold or students classified as ‘high risk’ who actually met or exceeded the proficiency threshold) decreased in comparison with the numbers from the early elementary age group analyses.

Exhibit Grade4.6. Final Model – Risk Level Based on Box Plot Distribution, Grade 4

Total numbers of students in sample by risk levels						
Increased risk level	Estimate For Probability of Risk	Frequency	Percent	Low risk	Moderate risk	High risk
1	< or = 0.1	13,287	21.2	13,287	0	0
2	< or = 0.2	10,907	17.4	10,907	0	0
3	< or = 0.3	4,334	6.9	4,334	0	0
4	< or = 0.4	5,172	8.2	0	5,172	0
5	< or = 0.5	3,694	5.9	0	3,694	0
6	< or = 0.6	2,683	4.3	0	2,683	0
7	< or = 0.7	4,260	6.8	0	0	4,260
8	< or = 0.8	3,364	5.4	0	0	3,364
9	>0.8	15,073	24.0	0	0	15,073
Total		62,774	100.0	28,528	11,549	22,697

Exhibit Grade4.7. Final Model- Predictive Probability of Proficiency Based on Risk Level, Grade 4

Predictive Probability of Proficiency Based on Risk Level			
<i>Risk Level</i>	<i>Proficiency</i>		Total
	Below Threshold	Proficient or Above	
Low	3,375 11.83%	25,153 88.17%	28,528
Moderate	5,270 45.63%	6,279 54.37%	11,549
High	19,121 84.24%	3,576 15.76%	22,697
Total	27,766 44.23%	35,008 55.77%	62,774 100%

Fifth Grade: Analysis Results and Predicted Risk Levels

In fifth 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 fifth grade student is at risk of not meeting the combined outcome variable of achieving a score that is proficient or higher in both the sixth grade English language arts (ELA) and Mathematics (Math) MCAS (Exhibit Grade5.1).

Exhibit Grade5.1 Overview of Fifth Grade Risk Indicators

Grade:	5 (using fourth grade information)
Age Grouping:	Late elementary (4 th thru 6 th grade)
Risk Indicators Tested:	<p>Behavioral variables</p> <ul style="list-style-type: none"> • Suspensions, fall • Suspensions, end of year • Attendance rate, fall • Attendance rate, end of year • Mobility (more than one school within the school year) • Retention <p>Demographic variables</p> <ul style="list-style-type: none"> • Low income household- Free lunch • Low income household- Reduced price lunch • Special education level variables (4 total) • ELL status • Former LEP • Immigration status • Gender • Urban residence • Overage for grade (age 10 or older by Sept 1st of 4th grade year) <p>Other individual student variables</p> <ul style="list-style-type: none"> • School wide Title I • Targeted Title I <p>MEPA levels²⁷</p> <ul style="list-style-type: none"> • Beginner • Early Intermediate • Intermediate • Transitioning to regular classes <p>4th Grade MCAS Proficiency Levels</p> <ul style="list-style-type: none"> • Math <ul style="list-style-type: none"> ○ Warning ○ Needs Improvement ○ Proficient • English <ul style="list-style-type: none"> ○ Warning ○ Needs Improvement ○ Proficient
Academic Goal/ Outcome Variable:²⁸	Proficient or higher on the sixth grade ELA <i>and</i> Math MCAS; Not proficient on either is equal to zero for this outcome

²⁷ Due to small sample in individual MEPA levels, final model aggregates MEPA levels beginner to intermediate as a single indicator, leaving transitioning to regular classes and non-MEPA as 0 for this variable.

²⁸ For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not being proficient or higher on the sixth third grade ELA and/or Math MCAS.

NOTE: A total of 67,403 observations included this combined outcome variable for the final model. Approximately 56 percent were characterized as proficient or above in both math and ELA, and 44 percent were less than proficient in one or both.

Fifth 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, and MEPA and MCAS, 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 Grade5.2). This analysis was used to inform the construction of the risk models tested (Exhibit Grade5.3).

Exhibit Grade5.2. Simple Logistic Regression Overview, Grade 5

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
<i>Demographic variables (Yes/No)</i>					
Low income household- Free lunch	1.56	0.02	<.0001	0.1017	64,790
Low income household- Reduced price lunch	0.97	0.03	<.0001		
<i>Special education</i>					
Low level of need (less than 2 hours)	1.16	0.05	<.0001	0.1417	64,790
Low level of need (2 or more hours)	1.85	0.05	<.0001		
Moderate level of need	2.33	0.04	<.0001		
High level of need	3.55	0.11	<.0001		
Immigration status [†]	0.15	0.07	0.032	0.0001	64,790
Sex: Female	-0.21	0.02	<.0001	0.0027	64,790
ELL status	1.45	0.05	<.0001	0.0175	64,790
Former LEP student [†]	0.32	0.05	<.0001	0.0006	64,790
Overage for grade	1.33	0.04	<.0001	0.0422	64,790
Urban residence	1.06	0.02	<.0001	0.0550	64,790
<i>Suspension</i>					
Suspensions, fall [†]	1.74	0.23	<.0001	0.0016	64,500
Suspensions, end of year	1.05	0.05	<.0001	0.0123	64,790
<i>Attendance</i>					
Attendance rate, fall [†]	-4.02	0.18	<.0001	0.0086	64,500
Attendance rate, end of year	-10.48	0.25	<.0001	0.0299	64,790
<i>Mobility - Changed schools during school year (Yes/No)</i>					
Retained (Yes/No)	1.15	0.06	<.0001	0.0073	64,790
Retained (Yes/No)	2.26	0.17	<.0001	0.0043	64,790
<i>Title I participation (Yes/No)</i>					
School-wide	1.27	0.02	<.0001	0.0871	64,790
Targeted	1.70	0.04	<.0001		
<i>MEPA Levels (Yes/No)</i>					
Low level (Beginner to intermediate)	2.68	0.09	<.0001	0.021	64,790

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
4th Grade MCAS Proficiency Levels					
MATH					
Warning	6.08	0.08	<.0001	0.355	64,790
Needs Improvement	3.02	0.03	<.0001		
Proficient	1.03	0.03	<.0001		
ENGLISH					
Warning	4.84	0.06	<.0001	0.292	64,790
Needs Improvement	2.25	0.04	<.0001		
Proficient	.331	0.04	<.0001		

Exhibit Reads: students with a high level of need are 3.55 higher in the log-odds of not being proficient in ELA and/or Math MCAS than others.

Fifth Grade: Risk Models Overview and Final Model

In total, we tested several potential risk models²⁹ (Exhibit Grade5.2). After testing the statistical significance of the interaction of two predictors respectively, the interaction terms were not included in the Final model, and three interaction effects were statistically significant – interactions between mobility and retention, between gender and suspensions, and between overage and urban residence. However, adding three more interaction effects into the final model did not much improve the prediction accuracy, and the proportions of students who did not meet the outcome threshold in each designated risk level were almost identical between the Final model and the model with interaction terms (see Exhibit Grade5.7 based on the Final model). Moreover, the coefficient of the interaction between mobility and retention was statistically negative, and did not make sense, because this implies that students who were retained and moved the school during the school year were less likely to fall off the track. Therefore, model 5 was accepted as the final fifth grade risk model, because it is as predictive as the model with some interaction terms and because it is a simpler model.

²⁹ For a subset of students whose MCAS measures were missing, the decision was made that such students will be automatically flagged as ‘moderate risk’, and if possible teachers or school personnel are recommended to further determine whether or not the students need supplementary preventions based on local information.

Exhibit Grade5.3. Overview of Findings by Model, Fifth Grade

Variable	Logistic Regression Analysis				
	Model 1	Model 2	Model 3	Model 4	Final Model Model 5
Behavioral variables					
Attendance, Fall†	-0.84***				
Attendance, end of year	-9.16***	-5.90***	-5.90***	-5.88***	-4.78***
Suspensions, Fall†	0.14				
Suspensions, end of year	0.89***	0.38***	0.37***	0.37***	0.09**
Mobility, Changed schools by the end of year	1.02***	0.51***	0.56***	0.56***	0.57***
Retention	2.18***	0.85***	0.78***	0.80***	0.82***
Demographic variables					
Low income household- Free lunch		1.11***	0.98***	0.98***	0.57***
Low income household- Reduced price lunch		0.73***	0.61***	0.61***	0.31***
Special education status					
Low level of need (less than 2 hours)		1.23***	1.22***	1.22***	0.63***
Low level of need (2 or more hours)		1.79***	1.79***	1.78***	0.95***
Moderate level of need		2.28***	2.33***	2.32***	1.26***
High level of need		3.19***	3.29***	3.28***	1.81***
ELL Status†		0.77***	0.61***	0.50***	
Former LEP†		-0.22**			
Immigration status†		-0.61***			
Sex: Female		-0.01	-0.01	-0.01	-0.02
Urban residence		0.48***	0.28***	0.28***	0.11***
Overage for grade		0.57***	0.55***	0.54***	0.40***
Other Indicators					
School wide Title I			0.47***	0.47***	0.38***
Targeted Title I			1.70***	1.70***	0.95***
MEPA Levels³⁰ (Yes/No)					
Low level (Beginner to intermediate)				2.41***	2.21***
4th Grade MCAS Proficiency Levels					
MATH					
Warning					4.37***
Needs Improvement					2.46***
Proficient					0.95***
ENGLISH					

³⁰ Due to small sample sizes in categories, final model groups beginning to intermediate levels into one category, leaving transitioning to regular classes and non-MEPA as the reference group.

	Logistic Regression Analysis				
Variable	Model 1	Model 2	Model 3	Model 4	Final Model Model 5
Warning					1.60***
Needs Improvement					0.64***
Proficient					0.28***
r ²	0.0460	0.2412	0.2601	0.2619	0.437

†Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

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

Exhibit Grade5.4 provides the summary statistics for the Final model. The estimates in column 2 denote the expected difference in the log-odds of not being proficient in our combined outcome variable—sixth grade ELA and/or Math MCAS, holding constant other variables in the model. With the exception of attendance and gender variables, all other variables are statistically positively associated with the recoded outcome variable. For example, students that are overage for when they were in fourth grade are expected to score 0.40 points higher than other students in the log-odds of not being proficient in ELA and/or Math MCAS, holding other variables constant.

Exhibit Grade5.4. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, and MCAS

Variable	Estimate	S.E.	Pr > t
Behavioral variables			
Attendance rate, end of year	-4.78	0.31	<.0001
Suspensions, end of year	0.09	0.03	.007
Mobility - Changed schools during school year	0.57	0.06	<.0001
Demographic variables			
Low income household- Free lunch	0.57	0.03	<.0001
Low income household- Reduced price lunch	0.31	0.05	<.0001
Special Education			
Low level of need (less than 2 hours)	0.63	0.06	<.0001
Low level of need (2 or more hours)	0.95	0.06	<.0001
Moderate level of need	1.26	0.05	<.0001
High level of need	1.81	0.13	<.0001
Retained	0.82	0.20	<.0001
Sex: Female	-0.02	0.02	.451
Urban residence	0.11	0.04	0.003
Overage for grade	0.40	0.04	<.0001
Other variables			
School wide Title I	0.38	0.04	0.001
Target Title I	0.95	0.05	<.0001
MEPA Levels			
Low level (Beginner to intermediate)	2.21	0.13	0.0007
4 th Grade MCAS Proficiency Levels			
MATH			
Warning	4.37	0.09	<.0001
Needs Improvement	2.46	0.04	<.0001
Proficient	0.95	0.04	<.0001
ENGLISH			
Warning	1.60	0.08	<.0001
Needs Improvement	0.64	0.05	<.0001
Proficient	0.28	0.05	<.0001

R²=0.492

Number of observations=67403

Fifth Grade: Illustration of Levels of Risk and MCAS Outcomes Using the Final Model

The following box plots show the distribution of test scores by increased risk in ELA and math, respectively, using our Final model. As the risk level increases (x axis), the proficiency level appears to decrease (y axis).

Exhibit Grade5.5 Final Model– Box plot distribution, Grade 5 Risk and 6th Grade ELA outcome

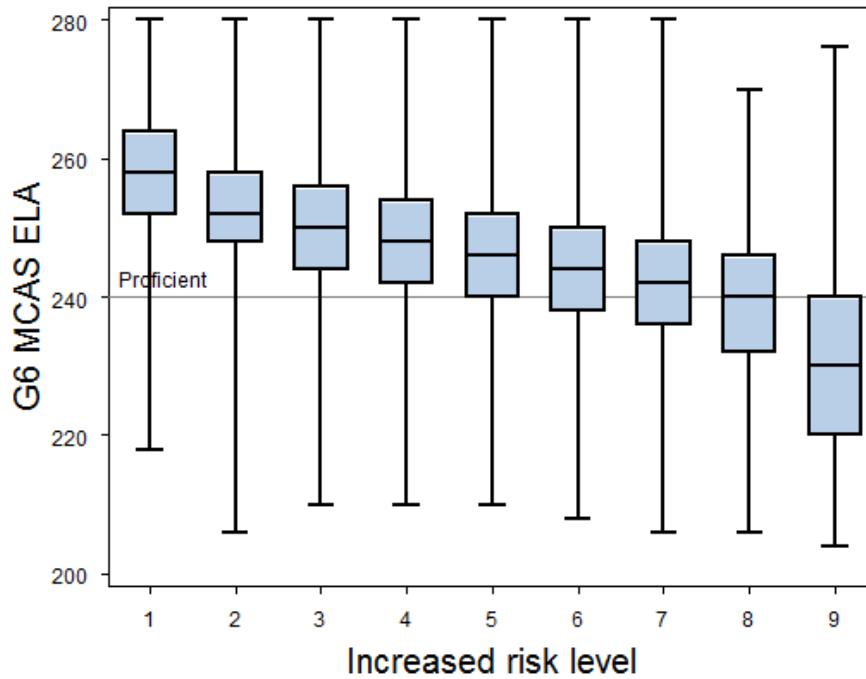
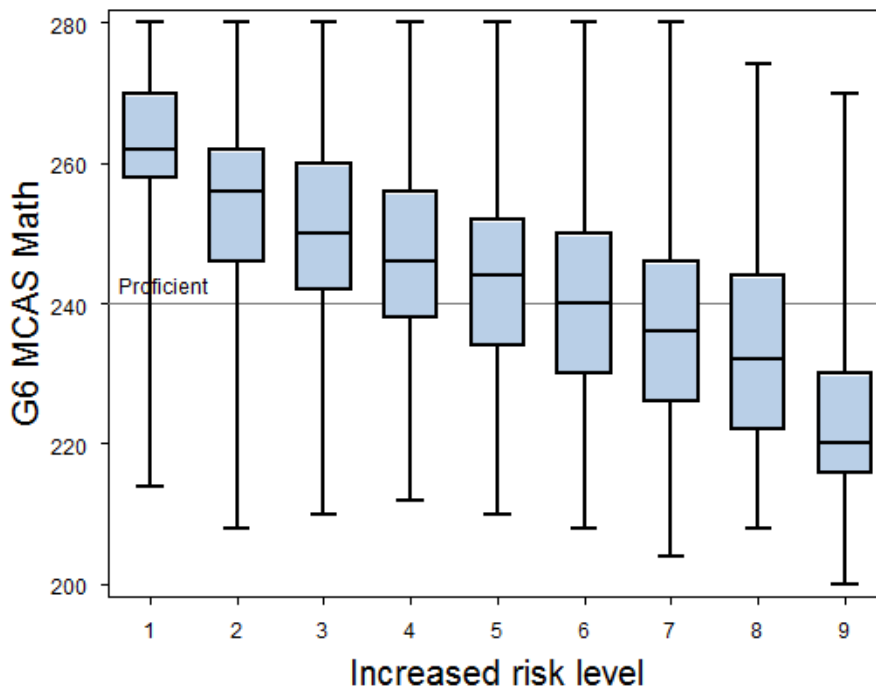


Exhibit Grade5.6 Final Model– Box plot distribution, Grade 5 and 6th Grade Math outcome



Based on the distributions of test scores by increased risk in ELA and math, respectively, the levels of risk are defined as follows:

- Low Risk (approximately 75% or more of students meet the outcome variable): Intervals 1-3;
- Moderate Risk (approximately half or more than half of the students meet the outcome variable): Intervals 4-6; and
- High Risk (approximately a third or less of the students meet the outcome variable): Intervals 7-9.

The statistics for the Final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade5.7 and Grade5.8. In summary, approximately 89 percent of students who fall into the low risk category have met or exceeded the proficiency level in both ELA and math on the grade 6 MCAS. Of the students who are categorized in the moderate risk category, 52 percent of the students have met the outcome. Among the high risk students approximately 15 percent met the outcome variable and 85 percent of the students scored below proficient on the six grade ELA and/or math MCAS. Note that as assessment data (MCAS test scores) were included in the risk model, the prediction accuracy rates in the late elementary group analysis increased, and the actual numbers of students that were incorrectly identified (either students classified as ‘low risk’ who actually did not meet the threshold or students classified as ‘high risk’ who actually met or exceeded the proficiency threshold) decreased in comparison with the numbers from the early elementary age group analyses.

Exhibit Grade5.7. Final Model – Risk Level Based on Box Plot Distributions, Grade 5

Total numbers of students in sample by risk levels						
Increased risk level	Estimate For Probability of Risk	Frequency	Percent	No to low risk	Moderate risk	High risk
1	≤ 0.1	15,227	22.6	15,227	0	0
2	>0.1 & ≤ 0.2	9,513	14.1	9,513	0	0
3	>0.2 & ≤ 0.3	4,635	6.9	4,635	0	0
4	>0.3 & ≤ 0.4	5,290	7.8	0	5,290	0
5	>0.4 & ≤ 0.5	2,810	4.2	0	2,810	0
6	>0.5 & ≤ 0.6	5,570	8.3	0	5,570	0
7	>0.6 & ≤ 0.7	3,497	5.2	0	0	3,497
8	>0.7 & ≤ 0.8	4,664	6.9	0	0	4,664
9	>0.8	16,197	24.0	0	0	16,197
Total		67,403	100.0	29,375	13,670	24,358

Exhibit Grade5.8. Final Model - Predictive Probability of Proficiency Based on Risk Level, Grade 5

Predictive Probability of Proficiency Based on Risk Level			
<i>Risk Level</i>	<i>Proficiency</i>		Total
	Below Threshold	Proficient or Above	
Low	3,127 10.65%	26,248 89.35%	29,375
Moderate	6,562 48.00%	7,108 52.00%	13,670
High	20,717 85.05%	3,641 14.95%	24,358
Total	30,406 56.89%	36,997 44.11%	67,403

Missing MCAS Recode:

As mentioned earlier, ESE determined that students with missing data in pretest measures were automatically identified as 'moderate risk'. Although we do not provide a table, the descriptive statistics show a tendency that students without pretest measures have a higher percentage on some key variables in comparison with students having MCAS pretest measures - school mobility (28.2% vs.2.5%), free lunch (41.9% vs.24.7%), overage for grade (19.3% vs. 12.1%), urban (47.1% vs.29.5%), immigration (18.3% vs. 1.2%), MEAP level 1(8.1% vs.0.1%), MEAP level 2 (5.3% vs. 0.2%), MEPA level 3 (7.0% vs. 1.1%). The following tables show the distributions of 6th grade MCAS proficiency in ELA and math for cases without pretest measures. Overall, the proportion of students with missing MCAS scores who failed to meet the academic goal mirror the proportion of moderate students at risk who met the outcome.

Exhibit Grade5.9. Late Elementary Outcome Variable (6th Grade MCAS Proficiency in ELA and Math) for Cases without Pretest Measures, Grade 5

Grade 6 Outcome	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	1,538	59.82	1,538	59.82
1	1,033	40.18	2,571	100.00

Exhibit Grade5.10. 6th Grade MCAS Proficiency in ELA for Cases without Pretest Measures, Grade 5

ELA Proficiency	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Above Proficient	292	11.36	292	11.36
Needs Improvement	663	25.79	955	37.15
Proficient	1,175	45.70	2,130	82.85
Warning	441	17.15	2,571	100.00

Exhibit Grade5.11. 6th Grade MCAS Proficiency in Math for Cases without Pretest Measures, Grade5

Math Proficiency	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Above Proficient	486	18.90	486	18.90
Needs Improvement	708	27.54	1,194	46.44
Proficient	688	26.76	1,882	73.20
Warning	689	26.80	2,571	100.00

Sixth Grade: Analysis Results and Predicted Risk Levels

For sixth grade, several models were tested to: 1) identify individual indicators of risk and 2) identify the risk model that is predictive of whether a rising sixth grade student is at risk of not meeting the outcome variable of achieving a score that is proficient or higher in both ELA and math MCAS in grade 6 (Exhibit Grade6.1).

Exhibit Grade6.1 Overview of Sixth Grade Risk Indicators

Grade:	6 (using data from grade 5 students)
Age Grouping:	Late elementary (4 th through 6 th grade)
Risk Indicators Tested:	<p>Behavioral variables</p> <ul style="list-style-type: none"> • Suspensions, fall (not included in Final model) • Suspensions, end of year • Attendance rate, fall (not included in Final model) • Attendance rate, end of year • Mobility (more than one school within the school year) • Retention <p>Demographic variables</p> <ul style="list-style-type: none"> • Low income household- Free lunch • Low income household- Reduced price lunch • Special education level variables (4 total) • ELL status (not included in Final model) • Former LEP (not included in Final model) • Immigration status (not included in Final model) • Gender • Urban residence • Overage for grade (age 11 or older by Sept 1st of 5th grade year) <p>Other individual student variables</p> <ul style="list-style-type: none"> • School wide Title I • Targeted Title I <p>MEPA levels³¹</p> <ul style="list-style-type: none"> • Beginner • Early Intermediate • Intermediate • Transitioning to regular classes I • Transitioning to regular classes II <p>3rd Grade MCAS Proficiency Levels</p> <ul style="list-style-type: none"> • Math <ul style="list-style-type: none"> ○ Warning ○ Needs Improvement ○ Proficient • English <ul style="list-style-type: none"> ○ Warning ○ Needs Improvement ○ Proficient
Academic Goal/ Outcome Variable: ³²	Proficient or higher on the sixth grade English language arts <i>and</i> Math MCAS; Not proficient on either is equal to zero for this outcome

³¹ Due to small samples in MEPA categories, levels were aggregated for final analyses: Levels 1-3 (beginner to intermediate) were made into one category, and level 4 (Transitioning to regular classes I) was kept as a separate variable. The highest level and non-MEPA were used as a reference.

NOTE: A total of 69,452 observations included this combined outcome variable for the final model. Approximately 55 percent were characterized as proficient or above in both math and ELA, and the remaining 45 percent were less than proficient in one or both.

Sixth Grade: Simple Logistics – Analysis of Individual Indicators

In order to build the most efficient and accurate model for the EWIS, we first examined a number of behavioral, demographic, and other indicators 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 Grade6.2). This analysis was used to inform the construction of the risk models tested.

Exhibit Grade6.2. Simple Logistic Regression Overview, Grade 6

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
Demographic variables (Yes/No)					
Low income household- Free lunch	1.58	0.02	<.0001	0.1068	66,594
Low income household- Reduced price lunch	0.99	0.03	<.0001		
Special education					
Low level of need (less than 2 hours)	1.22	0.05	<.0001	0.1566	66,594
Low level of need (2 or more hours)	1.90	0.05	<.0001		
Moderate level of need	2.45	0.04	<.0001		
High level of need	3.79	0.11	<.0001		
Immigration status [†]	0.22	0.08	0.0043	0.0001	66,594
Sex: Female	-0.21	0.02	<.0001	0.0027	66,594
ELL status	1.61	0.05	<.0001	0.0188	66,594
Former LEP student [†]	0.36	0.05	<.0001	0.0009	66,594
Overage for grade	1.35	0.03	<.0001	0.0442	66,594
Urban residence	1.07	0.02	<.0001	0.0559	66,594
Suspension					
Suspensions, fall [†]	0.49	0.11	<.0001	0.0004	66,354
Suspensions, end of year	0.87	0.04	<.0001	0.0144	66,506
Attendance					
Attendance rate, fall [†]	-4.44	0.17	<.0001	0.0110	66,354
Attendance rate, end of year	-11.26	0.24	<.0001	0.0366	66,506
Mobility - Changed schools during school year (Yes/No)	1.21	0.06	<.0001	0.0075	66,594
Retained (Yes/No)	1.74	0.15	<.0001	0.0026	66,594

³² For running the statistical regression models, the outcome variable was recoded to predict the risk/likelihood of not being proficient or higher on the sixth third grade ELA and/or Math MCAS.

Simple Logistic regression: Individual indicators (predictor)					
Variable	Estimate	S.E.	Pr > ChiSq	R-Square	N
Title I participation (Yes/No)					
School-wide	1.24	0.02	<.0001	0.0786	66,594
Targeted	1.55	0.04	<.0001		
MEPA Levels (Yes/No)					
Low level (Beginning to Intermediate)	3.81	0.22	<.0001	0.0310	66,594
Transitioning to regular classes I	2.17	0.08	<.0001		
Transitioning to regular classes II	0.25	0.07	0.0008		
5th Grade MCAS Proficiency Levels					
MATH					
Warning	6.66	0.08	<.0001	0.425	66,594
Needs Improvement	3.52	0.04	<.0001		
Proficient	1.40	0.04	<.0001		
ENGLISH					
Warning	6.53	0.13	<.0001	0.337	66,594
Needs Improvement	3.58	0.03	<.0001		
Proficient	1.20	0.03	<.0001		

Exhibit Reads: students with a high level of need are 3.79 higher in the log-odds of not being proficient in ELA and/or Math MCAS than others.

†Indicator was removed from final analyses, because either the direction of the coefficient of the variable was changed, or it was not statistically significant at an alpha level of .05 and the estimated coefficient is nearly zero.

Sixth Grade Overview of Final Model

Exhibit Grade6.3 provides the summary statistics for the Final model. The estimates in column 2 denote the expected difference in the log-odds of not being proficient in our combined outcome variable—sixth grade ELA and/or Math MCAS, holding constant other variables in the model. With the exception of attendance and gender, all other variables are statistically positively associated with the recoded outcome variable. For example, students that moved schools during the school year are expected to score 0.43 points higher than other students in the log-odds of not being proficient in ELA and/or Math MCAS, holding other variables constant.

Exhibit Grade6.3. Final Model – Behavioral Variables, Demographic Variables, Other Variables, MEPA Levels, and MCAS

Variable	Estimate	S.E.	Pr > t
Behavioral variables			
Attendance rate, end of year	-4.94	0.32	<.0001
Suspensions, end of year	0.09	0.03	0.002
Mobility - Changed schools during school year	0.43	0.07	<.0001
Demographic variables			
Low income household- Free lunch	0.52	0.03	<.0001
Low income household- Reduced price lunch	0.29	0.05	<.0001
Special Education			
Low level of need (less than 2 hours)	0.59	0.07	<.0001
Low level of need (2 or more hours)	0.90	0.06	<.0001
Moderate level of need	1.23	0.05	<.0001
High level of need	1.98	0.14	<.0001
Retained	0.10	0.02	<.0001
Gender: Female	-0.08	0.02	0.001
Urban residence	0.16	0.04	<.0001
Overage for grade	0.27	0.04	<.0001
Other variables			
Target Title I	0.69	0.04	<.0001
School wide Title I	0.19	0.06	<.0001
MEPA Levels ³³			
Low (beginner to intermediate)	4.17	0.16	<.0001
5 th Grade MCAS Proficiency Levels			
MATH			
Warning	5.04	0.08	<.0001
Needs Improvement	2.98	0.04	<.0001
Proficient	1.30	0.04	<.0001
ENGLISH			
Warning	2.37	0.14	<.0001
Needs Improvement	1.61	0.05	<.0001
Proficient	0.42	0.04	<.0001
R ² =0.494			
Number of observations=69452			

³³ Fifth grade introduces 5 MEPA levels. Levels 1-3 are categorized as low and Level 4 is categorized as Transitioning to regular classes I. Level 5 (Transitioning to regular classes II and non-MEPA are the reference category.

Sixth Grade: Illustration of Levels of Risk and MCAS Outcomes Using the Final Model

The following box plot shows the distribution of test scores by increased risk, using our Final model. As the risk level increases (x axis), the proficiency level appears to decrease (y axis).

Exhibit Grade6.4. Final Model– Box plot distribution 6th Grade ELA outcome

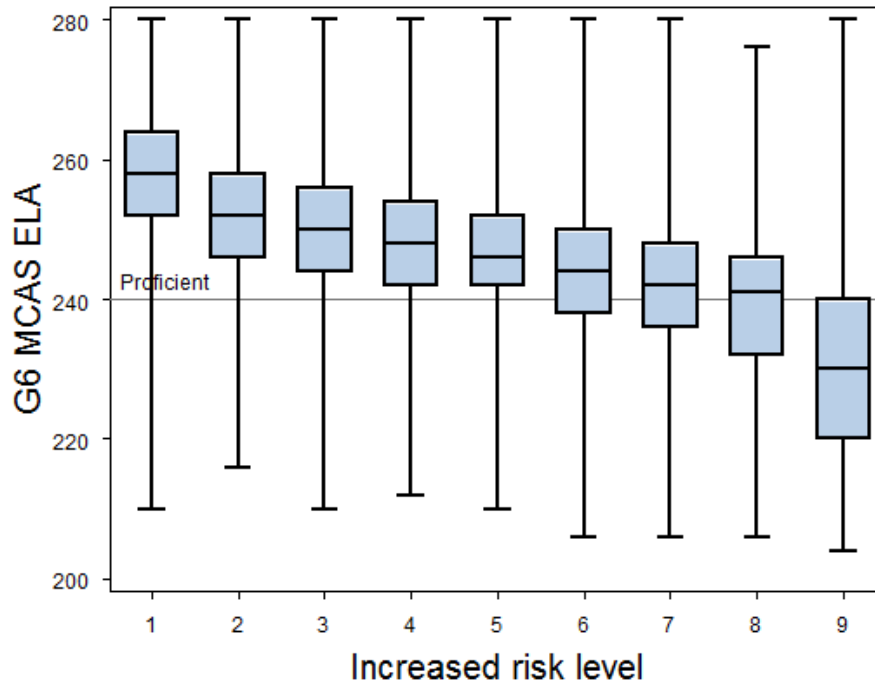
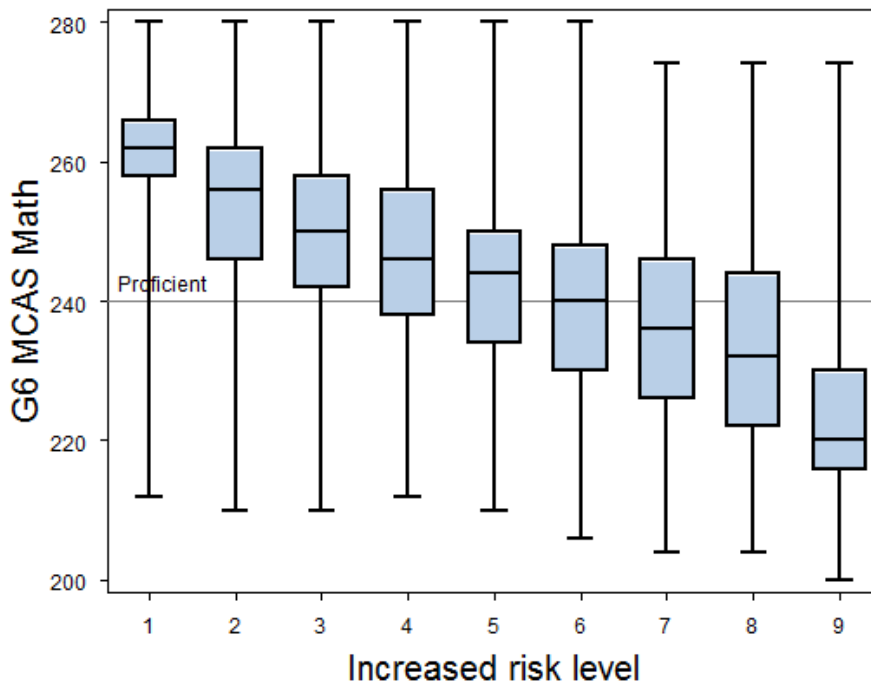


Exhibit Grade6.5. Final Model– Box plot distribution 6th Grade Math outcome



Based on the distributions of test scores by increased risk in ELA and math, respectively, the levels of risk are defined as follows:

- Low Risk (approximately 75% or more of students meet the outcome variable) : Intervals 1-3;
- Moderate Risk (approximately half or more than half of the students meet the outcome variable) : Intervals 4-6; and
- High Risk (approximately a third or less of the students meet the outcome variable) : Intervals 7-9.

The statistics for the Final model’s three levels of risk (low risk; moderate risk and high risk) are shown in Exhibits Grade6.6 and Grade6.7. In summary, approximately 90 percent of students who fall into the low risk category have met the proficiency in both ELA and math on the 6th grade MCAS. Of the students who are categorized in the moderate risk category, approximately 51 percent of the students have met the outcome. Among the high risk students approximately 12 percent met the outcome proficiency level and 88 percent of the students scored below proficient on the six grade proficiency in ELA or math.

Exhibit Grade6.6. Final Model – Risk Level Based on Box Plot Distributions, Grade 6

Total numbers of students in sample by risk levels						
Increased risk level	Estimate For Probability of Risk	Frequency	Percent	No to low risk	Moderate risk	High risk
1	≤ 0.1	16,652	24	16,652	0	0
2	>0.1 & ≤ 0.2	12,377	17.8	12,377	0	0
3	>0.2 & ≤ 0.3	3,365	4.8	3,365	0	0
4	>0.3& ≤ 0.4	2,657	3.8	0	2,657	0
5	>0.4 & ≤ 0.5	4,797	6.9	0	4,797	0
6	>0.5 & ≤ 0.6	2,765	4	0	2,765	0
7	>0.6 & ≤ 0.7	2,655	3.8	0	0	2,655
8	>0.7 & ≤ 0.8	4,015	5.8	0	0	4,015
9	>0.8	20,169	29	0	0	20,169
Total		69,452	100	32,394	10,219	26,839

Exhibit Grade6.7. Final Model - Predictive Probability of Proficiency Based on Risk Level, Grade 6

Predictive Probability of Proficiency Based on Risk Level			
<i>Risk Level</i>	<i>Proficiency</i>		Total
	Below Threshold	Proficient or Above	
Low	3,123 9.64%	29,271 90.36%	32,394
Moderate	4,958 48.52%	5,261 51.48%	10,219
High	23,576 87.83%	3,263 12.16%	26,839
Total	31,657 45.58%	37,795 54.42%	69,452

Late Elementary Validation: Comparison of 2008-09 to 2009-10 Cohort

In order to 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 (proficient or advanced score on both ELA and Math Grade 6 MCAS). Exhibit Late Elementary Validation.1 shows that overall the predictive probability of proficiency by risk level is very similar between the original cohort and the validation cohort in grades 4-6.

Exhibit Late Elementary Validation.2 shows the output from running the logistical regression of grade 4, 5, and 6 models using the original cohort and the validation cohort. The coefficients are all generally similar in magnitude and significance, except for urban resident and proficient in ELA in Grade 5, where the coefficients declined and were no longer significant in the validation year. In addition, the directions of the coefficients are the same between the models. However, 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 model for late elementary is 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 the 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 Late Elementary Validation.1 Predictive Probability of Proficiency Original Cohort vs. Validation Cohort, Grades 4-6

Predictive Probability of Proficiency Based on Risk Level FOURTH GRADE				
<i>Risk Level</i>	Below Threshold		Proficient or Above	
	2009-10 cohort	2008-09 cohort	2009-10 cohort	2008-09 cohort
Low	3,375 11.83%	2,424 10.58%	25,153 88.17%	20,482 89.42%
Moderate	5,270 45.63%	5,612 41.07%	6,279 54.37%	8,052 58.93%
High	19,121 84.24%	22,282 81.13%	3,576 15.76%	5,183 18.87%
Total	27,766 44.23%	30,318 47.35%	35,008 55.77%	33,717 52.65%

Predictive Probability of Proficiency Based on Risk Level FIFTH GRADE				
<i>Risk Level</i>	Below Threshold		Proficient or Above	
	2009-10 cohort	2008-09 cohort	2009-10 cohort	2008-09 cohort
Low	3,641 14.95%	3,711 13.19%	20,717 85.05%	24,754 86.96%
Moderate	7,108 52.00%	6,892 51.12%	6,562 48.00%	6,589 48.88%
High	26,248 89.35%	21,802 86.81%	3,127 10.65%	21,082 13.19%
Total	36,997 44.23%	31,685 47.84	30,406 55.77%	31,685 52.16%

Predictive Probability of Proficiency Based on Risk Level SIXTH GRADE				
<i>Risk Level</i>	Below Threshold		Proficient or Above	
	2009-10 cohort	2008-09 cohort	2009-10 cohort	2008-09 cohort
Low	3,123 9.64%	3,346 10.91%	29,271 90.36%	27,323 89.09%
Moderate	4,958 48.52%	5,603 52.41%	5,261 51.48%	5,088 47.59%
High	23,576 87.83%	23,957 89.50%	3,263 12.16%	2,811 10.50%
Total	31,657 45.58	32,906 48.30%	37,795 54.42%	35,222 51.70%

Exhibit Late Elementary Validation.2. Overview of Findings by Cohort Using Final Model

Variable	Grade 4		Grade 5		Grade 6	
	Original Cohort (2009-10)	Validation Cohort (2008-09)	Original Cohort (2009-10)	Validation Cohort (2008-09)	Original Cohort (2009-10)	Validation Cohort (2008-09)
Behavioral variables						
Attendance rate, end of year	-3.96***	-4.29***	-4.78***	-3.99***	-4.94***	-5.17***
Suspensions, end of year	0.21***	0.22***	0.09**	0.18***	0.09***	0.12***
Mobility-Changed schools during sy	0.16*	0.32**	0.57***	0.22***	0.43***	0.82***
Demographic variables						
Low income household-Free lunch	0.52***	0.58***	0.57***	0.68***	0.52***	0.50***
Low income household-Reduced price	0.35***	0.36***	0.31***	0.38***	0.29***	0.28***
Special Education						
Low level of need (less than 2 hours)	0.59***	0.60***	0.63***	0.69***	0.59***	0.62***
Low level of need (2 or more hours)	0.95***	1.04***	0.95***	0.90***	0.90***	0.78***
Moderate level of need	1.11***	1.35***	1.26***	1.26***	1.23***	1.13***
High level of need	1.75***	2.01***	1.81***	2.15***	1.98***	2.57***
Gender: Female	-0.14***	-0.16***	-0.02	-0.09***	-0.08***	-0.18***
Urban residence	0.03	0.02	0.11***	0.04	0.16***	0.04***
Overage for grade	0.42***	0.23***	0.40***	0.50***	0.27***	0.34***
Retained	0.48***	0.89***	0.82***	0.50***	0.10***	0.06***
Other variables						
Target Title I	0.65***	0.70***	0.95***	0.82***	0.69***	0.90***
School wide Title I	0.36***	0.42***	0.38***	0.49***	0.19***	0.39***
MEPA Levels						
Low Levels	.12*	0.14*	2.21***	1.00*	4.17***	3.26***
MCAS Proficiency Levels						
MATH						
Warning	3.79***	4.07***	4.37***	4.42***	5.04***	5.08***
Needs Improvement	2.45***	2.67***	2.46***	2.25***	2.98***	3.02***
Proficient	1.24***	1.37***	0.95***	0.76***	1.30***	1.29***
ENGLISH						
Warning	2.71***	2.80***	1.60***	2.06***	2.37***	2.69***
Needs Improvement	2.01***	1.97***	0.64***	1.40***	1.61***	1.49***
Proficient	1.04***	0.99***	0.28***	.16	0.42***	0.29***

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

Appendix A.1

The following serves an example of the indicators by risk level. The example in Exhibit A.1 shows the descriptive statistics for each indicator by risk level for the Final risk model for First Grade.

Descriptive Statistics for Indicators by Increased Risk Level (Final Model), First Grade

Increased risk level	Estimate For Probability of Risk	Variable	Mean	Std Dev
All levels N=59468	n/a	Grade 3 ELA MCAS Scaled Score	244.43	13.75
		Attendance rate	0.95	0.06
		Suspensions	0.01	0.19
		Mobility - Changed schools during school year	0.05	0.21
		Gender: Female	0.49	0.50
		Low income household-Free lunch	0.22	0.41
		Low income household-Reduced price lunch	0.05	0.21
		ELL Status	0.08	0.27
		Overage for grade	0.06	0.24
		Low level of need (less than 2 hours)	0.04	0.19
		Low level of need (2 or more hours)	0.02	0.14
		Moderate level of need	0.04	0.20
		High level of need	0.02	0.14
		Urban residence	0.31	0.46
		Target Title I	0.27	0.44
		School wide Title I	0.02	0.13
1 N= 420 students	≤ 0.1	Grade 3 ELA MCAS Scaled Score	255.00	11.25
		Attendance rate	0.97	0.02
		Suspensions	0.00	0.00
		Mobility - Changed schools during school year	0.00	0.00
		Gender: Female	1.00	0.00
		Low income household-Free lunch	0.00	0.00
		Low income household-Reduced price lunch	0.00	0.00
		ELL Status	0.00	0.00
		Overage for grade	0.00	0.00
		Low level of need (less than 2 hours)	0.00	0.00
		Low level of need (2 or more hours)	0.00	0.00
		Moderate level of need	0.00	0.00
		High level of need	0.00	0.00
		Urban residence	0.00	0.00
		Target Title I	0.00	0.00
		School wide Title I	0.00	0.00
2 N= 15,069 students	>0.1 & ≤ 0.2	Grade 3 ELA MCAS Scaled Score	251.48	11.36
		Attendance rate	0.96	0.03
		Suspensions	0.00	0.01
		Mobility - Changed schools during school year	0.01	0.08
		Gender: Female	0.66	0.47

Increased risk level	Estimate For Probability of Risk	Variable	Mean	Std Dev
		Low income household-Free lunch	0.00	0.01
		Low income household-Reduced price lunch	0.00	0.04
		ELL Status	0.00	0.06
		Overage for grade	0.03	0.16
		Low level of need (less than 2 hours)	0.00	0.04
		Low level of need (2 or more hours)	0.00	0.00
		Moderate level of need	0.00	0.00
		High level of need	0.00	0.00
		Urban residence	0.05	0.22
		Target Title I	0.02	0.15
		School wide Title I	0.00	0.01
3 N= 16,471 students	>0.2 & ≤ 0.3	Grade 3 ELA MCAS Scaled Score	247.35	11.87
		Attendance rate	0.96	0.04
		Suspensions	0.00	0.05
		Mobility - Changed schools during school year	0.02	0.15
		Gender: Female	0.48	0.50
		Low income household-Free lunch	0.02	0.13
		Low income household-Reduced price lunch	0.02	0.15
		ELL Status	0.01	0.12
		Overage for grade	0.05	0.21
		Low level of need (less than 2 hours)	0.02	0.15
		Low level of need (2 or more hours)	0.00	0.02
		Moderate level of need	0.00	0.00
		High level of need	0.00	0.00
		Urban residence	0.15	0.36
		Target Title I	0.10	0.30
		School wide Title I	0.00	0.06
4 N= 8571 students	>0.3 & ≤ 0.4	Grade 3 ELA MCAS Scaled Score	243.38	12.52
		Attendance rate	0.95	0.05
		Suspensions	0.00	0.10
		Mobility - Changed schools during school year	0.04	0.20
		Gender: Female	0.39	0.49
		Low income household-Free lunch	0.15	0.36
		Low income household-Reduced price lunch	0.08	0.27
		ELL Status	0.05	0.22
		Overage for grade	0.06	0.23
		Low level of need (less than 2 hours)	0.07	0.26
		Low level of need (2 or more hours)	0.01	0.09
		Moderate level of need	0.00	0.06
		High level of need	0.00	0.00
		Urban residence	0.34	0.47

Increased risk level	Estimate For Probability of Risk	Variable	Mean	Std Dev
		Target Title I	0.28	0.45
		School wide Title I	0.02	0.14
5 N= 5526 students	>0.4 & ≤ 0.5	Grade 3 ELA MCAS Scaled Score	240.41	12.67
		Attendance rate	0.94	0.06
		Suspensions	0.01	0.09
		Mobility - Changed schools during school year	0.07	0.26
		Gender: Female	0.46	0.50
		Low income household-Free lunch	0.47	0.50
		Low income household-Reduced price lunch	0.12	0.33
		ELL Status	0.09	0.29
		Overage for grade	0.06	0.23
		Low level of need (less than 2 hours)	0.09	0.29
		Low level of need (2 or more hours)	0.03	0.17
		Moderate level of need	0.03	0.18
		High level of need	0.00	0.00
		Urban residence	0.56	0.50
		Target Title I	0.51	0.50
		School wide Title I	0.05	0.21
6 N= 5041 students	>0.5 & ≤ 0.6	Grade 3 ELA MCAS Scaled Score	237.39	12.74
		Attendance rate	0.93	0.09
		Suspensions	0.02	0.19
		Mobility - Changed schools during school year	0.08	0.27
		Gender: Female	0.44	0.50
		Low income household-Free lunch	0.63	0.48
		Low income household-Reduced price lunch	0.10	0.30
		ELL Status	0.16	0.37
		Overage for grade	0.06	0.25
		Low level of need (less than 2 hours)	0.05	0.22
		Low level of need (2 or more hours)	0.05	0.21
		Moderate level of need	0.10	0.30
		High level of need	0.00	0.00
		Urban residence	0.69	0.46
		Target Title I	0.64	0.48
		School wide Title I	0.03	0.18
7 N=3842 students	>0.6 & ≤ 0.7	Grade 3 ELA MCAS Scaled Score	234.60	13.09
		Attendance rate	0.92	0.09
		Suspensions	0.03	0.23
		Mobility - Changed schools during school year	0.11	0.31
		Gender: Female	0.36	0.48
		Low income household-Free lunch	0.68	0.47
		Low income household-Reduced price lunch	0.07	0.26

Increased risk level	Estimate For Probability of Risk	Variable	Mean	Std Dev
		ELL Status	0.29	0.46
		Overage for grade	0.10	0.30
		Low level of need (less than 2 hours)	0.05	0.21
		Low level of need (2 or more hours)	0.05	0.21
		Moderate level of need	0.17	0.37
		High level of need	0.01	0.08
		Urban residence	0.73	0.45
		Target Title I	0.67	0.47
		School wide Title I	0.04	0.19
8 N= 2381 students	>0.7 & ≤ 0.8	Grade 3 ELA MCAS Scaled Score	231.59	12.88
		Attendance rate	0.92	0.10
		Suspensions	0.04	0.32
		Mobility - Changed schools during school year	0.12	0.32
		Gender: Female	0.29	0.46
		Low income household-Free lunch	0.69	0.46
		Low income household-Reduced price lunch	0.06	0.23
		ELL Status	0.41	0.49
		Overage for grade	0.15	0.36
		Low level of need (less than 2 hours)	0.05	0.22
		Low level of need (2 or more hours)	0.09	0.28
		Moderate level of need	0.21	0.41
		High level of need	0.09	0.28
		Urban residence	0.69	0.46
		Target Title I	0.62	0.48
		School wide Title I	0.05	0.22
9 N= 2147 students	>0.8	Grade 3 ELA MCAS Scaled Score	227.49	12.56
		Attendance rate	0.91	0.10
		Suspensions	0.13	0.76
		Mobility - Changed schools during school year	0.17	0.37
		Gender: Female	0.23	0.42
		Low income household-Free lunch	0.69	0.46
		Low income household-Reduced price lunch	0.07	0.26
		ELL Status	0.24	0.43
		Overage for grade	0.25	0.43
		Low level of need (less than 2 hours)	0.04	0.18
		Low level of need (2 or more hours)	0.13	0.33
		Moderate level of need	0.26	0.44
		High level of need	0.46	0.50
		Urban residence	0.69	0.46
		Target Title I	0.60	0.49
		School wide Title I	0.06	0.24

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