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Alignment Between STAR and MCA for Grades 10 and 11

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Alignment Between STAR and MCA for Grades 10 and 11

Executive Summary

STAR, the products from a software company, Renaissance, are used for screening and progress-monitoring overtime. An alignment was completed by Renaissance between STAR and MCA, the Minnesota Comprehensive Assessment, for grades 3 through 8. This research study will help contribute to the research of alignment between STAR and MCA. This research is predicting the expected STAR scores by season for student proficiency in MCA reading and math at 50% and 90% probability levels. The STAR scores needed to achieve 50% and 90% chance of MCA proficiency for each season will be calculated in this study. Overall, the STAR scores needed are increasing overtime. When a student is predicted to be non-proficient, this student will receive extra help. It is important to prevent the chances of predicting the wrong students to be MCA proficiency because they will not receive extra supports. So, a better probability cutoff (75%) will be suggested through this study.

Introduction

The Minnesota Comprehensive Assessments – III (MCA-III) are the state assessments for reading and math, which measure student proficiency in grade-level standards. Schools use the information to improve classroom teaching and learning. The MCA reading scale score is from 1001 to 1099; the MCA math scale score is from 1101 to 1199. The two digits in front of the MCA scale score refer to students' grades. STAR assessments are products of Renaissance and are used for screening, progress-monitoring, and diagnostic purposes. It measures progress overtime. Renaissance is a software company that helps educators to ensure that all students reach their full potential by understanding students' current learning progression. The STAR assessment scale score is from 0 to 1400. STAR reading tracks students' development in five domains: word knowledge and skills, comprehension strategies and constructing meaning, analyzing literary text, understanding author's craft, and analyzing argument and evaluating text. The STAR math will track development in four domains: numbers and operations; algebra; geometry and measurement; and data analysis, statistics, and probability.

The purpose of this research is to predict the probability of students' MCA proficiency in 10th-grade reading and 11th-grade math using STAR scores for each season (Fall, Winter, Spring) focusing on St. Cloud Area School District 742. This is the 15th largest school district in Minnesota. There are 718 students from 10th grade and 716 students from 11th grade represented in the data. The 10th graders completed the MCA reading in 2017; the 11th graders completed the MCA math in 2017. However, not all the students completed the STAR reading or math assessment. Students in honors or advanced classes do not test for one reason or another, or some took the test outside of the benchmark window, which would not be captured in the benchmark data.

An alignment study was completed by Renaissance between STAR and MCA for grades 3 through 8, but not for grades 10 and 11. Therefore, this study will help contribute to the research of alignment between STAR and MCA. The alignment study completed by Renaissance used 4 performance levels for the MCA assessments. These levels are "Does not meet the standards", "Partially meets the standards", "Meets the standards", and "Exceeds the standards". This study will use 2 performance levels for the MCA assessments, which are proficient and non-proficient. This research is predicting the expected STAR scores by season for student proficiency in MCA reading and math at 50% and 90% probability levels. The

STAR scores needed to achieve 50% and 90% chance of MCA proficiency for each season will be calculated in this study. Further research will explore different probability levels that will reduce the false positive rate (approximate 5 – 10%). A false positive means a student was predicted to be proficient when they were not.

Procedure

MCA reading and math data and STAR reading and math data were gathered from schools in St. Cloud. Students are recommended to take the STAR reading assessment during 9th and 10th grade and the STAR math assessment during 9th, 10th, and 11th grade. Two datasets were received for this research. The "reading" dataset has students' MCA scores in 10th-grade reading and STAR scores in reading for 6 seasons (2 years). The "math" dataset has students' MCA scores in 11th-grade math and STAR scores in math for 9 months (3 years).

6 logistic regression models were produced to predict students' MCA proficiency in 10th-grade reading. The scale scores of MCA are used to determine the proficiency; 1001 to 1099 or 1101 to 1199 are not the raw scores for students' MCA reading or math assessments. Students' MCA reading assessments' scores between 1050 and 1099 are categorized as proficient and between 1001 and 1049 are categorized as not proficient. Only one predictor variable is used in each logistic regression model. The 6 seasons' STAR scores in reading are the predictor variables for the 6 logistic regression models. A logistic regression model is a regression model where the dependent variable is dichotomous, only two categories/ possible outcomes. The logistic regression will then predict the probability of either in the categories. In this study, the MCA proficiency is the dependent variable with only two categories: proficient and non-proficient. Then, the expected STAR scores by season for student proficiency in MCA reading at 50%, 75%, and 90% probability levels were predicted using the logistic regression model's formula:

Formula 1:

$$p = \frac{e^{\beta_0+\beta_1 X}}{1 + e^{\beta_0+\beta_1 X}}$$

p is the probability predicted that the student will be proficient in the MCA reading, which are 0.5, 0.75, and 0.9; X is the STAR reading score; β_0 and β_1 are retrieved from the logistic regression models. The formula can also be read as:

Formula 2:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X$$

or,

Formula 3:

$$X = \frac{\ln\left(\frac{p}{1-p}\right) - \beta_0}{\beta_1}$$

X, the STAR scores will be calculated using the formula after the logistic regression models are produced. 9 logistic regression models were produced to predict students' MCA proficiency in 11th-grade math. Students' MCA math assessment between 1150 and 1199 are categorized as proficient and between 1101 and 1149 are categorized as not proficient. Like the 10th-grade reading, only one predictor variable is used in each logistic regression model. The same methods are used in the "math" dataset to predict the expected STAR scores by season for student proficiency in MCA math at 50%, 75%, and 90% probability levels.

Results

718 students represented in the "reading" dataset. There are 328 students who are MCA reading proficient, which is about 45.68% of the 10th graders (Table 1).

Table 1: MCA reading proficiency

MCA Reading	N
Proficient	328
Non-Proficient	390

716 students represented in the "math" dataset. There are 226 students who are MCA math proficient, which is about 31.56% of the 11th graders (Table 2).

Table 2: MCA math proficiency

MCA Math	N
Proficient	226
Non-Proficient	490

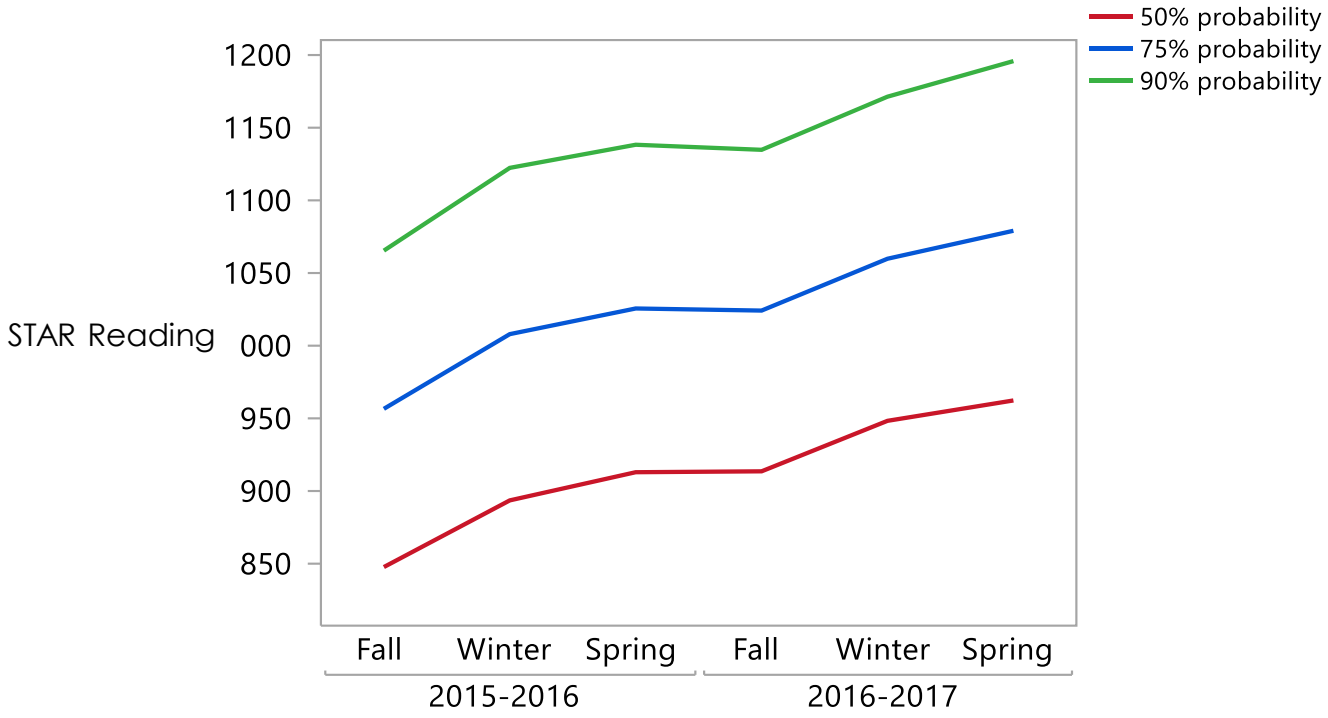
The 6 seasons' STAR scores in reading are the predictor variables for the 6 logistic regression models to predict students' MCA reading proficiency (Table 3). Since each logistic regression model has only one predictor variable, there are only one interaction, β_0, and one coefficient, β_1, for each logistic regression model. Then, the expected STAR reading scores by season for student proficiency in MCA reading at 50%, 75%, and 90% probability levels are calculated using Formula 3.

Table 3: 10th-grade expected STAR reading for MCA proficiency at different probability levels

STAR Reading Season	β_0	β_1	50% probability	75% probability	90% probability
Fall 2015-2016	-8.53	1.01	847	956	1066
Winter 2015-2016	-8.56	0.96	893	1008	1123
Spring 2015-2016	-8.88	0.97	913	1026	1139
Fall 2016-2017	-9.05	0.99	913	1024	1135
Winter 2016-2017	-9.32	0.98	948	1060	1172
Spring 2016-2017	-9.03	0.94	962	1079	1196

The β_1's are rescaled for the 6 logistic regression model by multiplying 100 (Table 3). The rescale means the changes of each STAR reading score is a 100 points instead of 1 point. When a student has a 100 points higher than another student in STAR reading during Fall 2015-2016, the student with higher points will have 1.01 more in the logit function. For example, student A received 900 during the STAR reading in Fall 2015-2016, this student will have 63% probability of MCA reading proficiency in his 10th grade, as calculated using Formula 1. Student B scored 1000 during the same season and will have 82% chance of MCA reading proficiency in his 10th grade. The 20% points increase is the effect of the 1.01 in the logit. A logit is the function we use for probability calculation.

Figure 1: Predicted STAR Reading scores at different probability levels



The expected STAR reading score to achieve different probability levels of MCA reading proficiency is shown in the line chart (Figure 1). The average difference between the probability levels is about 100 points. Students should score at or above the red line to achieve 50% or more chance of MCA reading proficiency, blue line for 75%, and green line for 90%.

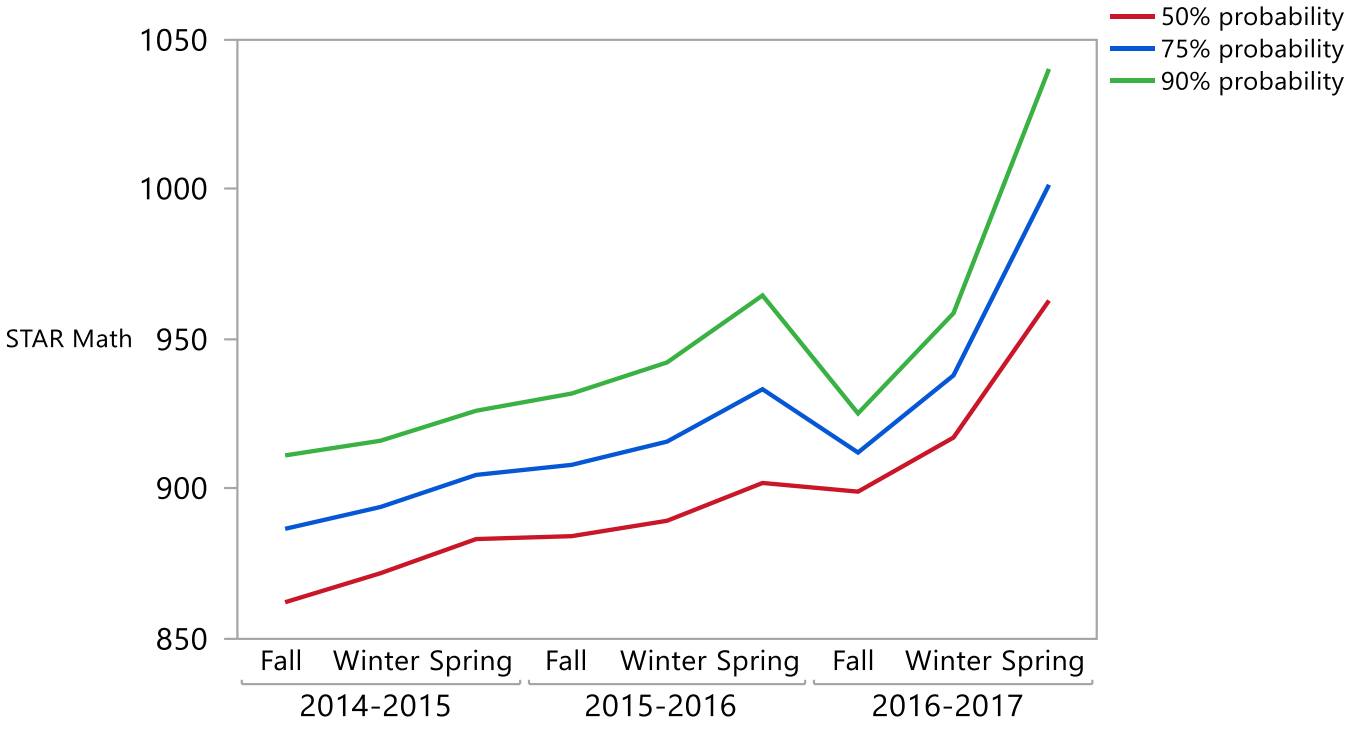
The same methods are used on the 9 logistic regression models to predict students' MCA math proficiency. The β_1's of the 9 logistic regression models are also rescaled (Table 4). The expected STAR math assessment scores by season for student proficiency in MCA math at 50%, 75%, and 90% probability levels are calculated using Formula 3.

Table 4: 11th-grade expected STAR math for MCA proficiency at different probability levels

STAR Math Season	β_0	β_1	50% probability	75% probability	90% probability
Fall 2014-2015	-38.65	4.48	862	887	911
Winter 2014-2015	-43.32	4.97	872	894	916
Spring 2014-2015	-45.30	5.13	883	905	926
Fall 2015-2016	-40.81	4.62	884	908	932
Winter 2015-2016	-36.97	4.16	889	916	942
Spring 2015-2016	-31.65	3.51	902	933	965
Fall 2016-2017	-75.64	8.41	899	912	925
Winter 2016-2017	-48.54	5.29	917	938	959
Spring 2016-2017	-27.36	2.84	963	1002	1040

The line chart shows the expected STAR math score to achieve different probability levels of MCA math proficiency (Figure 2). The average difference between the probability levels is about 24 points, which is smaller than the average difference in STAR reading.

Figure 2: Predicted STAR Math scores at different probability levels



These logistic regression models are run to find out the false positive and false negative rates. A false positive means a student is predicted to be proficient when they were not; a false negative means a student is predicted to be non-proficient when they were proficient. It is more important to prevent false positives than false negatives because students will not receive extra support if they were predicted as MCA proficient. When a higher probability cutoff is used, the false positive will decrease, but the false negative will increase. Probability cutoff at 0.75 is selected after exploring the three probability levels, which are 0.50, 0.75, and 0.90 (Appendix A). 0.75 is selected because the false positive rates of the logistic regression models are between 5% and 10%, and the false negative rates do not exceed 25% (Table 5 and 6). N represents the number of students who completed the STAR assessment during that specific season.

Table 5: False positive and false negative rate for each logistic regression model to predict MCA Reading proficiency (probability cutoff at 0.75)

STAR Reading Assessment	False Positive Rate	False Negative Rate	N
Fall 2015-2016	6%	24%	581
Winter 2015-2016	6%	21%	605
Spring 2015-2016	5%	18%	529
Fall 2016-2017	6%	17%	602
Winter 2016-2017	7%	17%	646
Spring 2016-2017	8%	20%	579

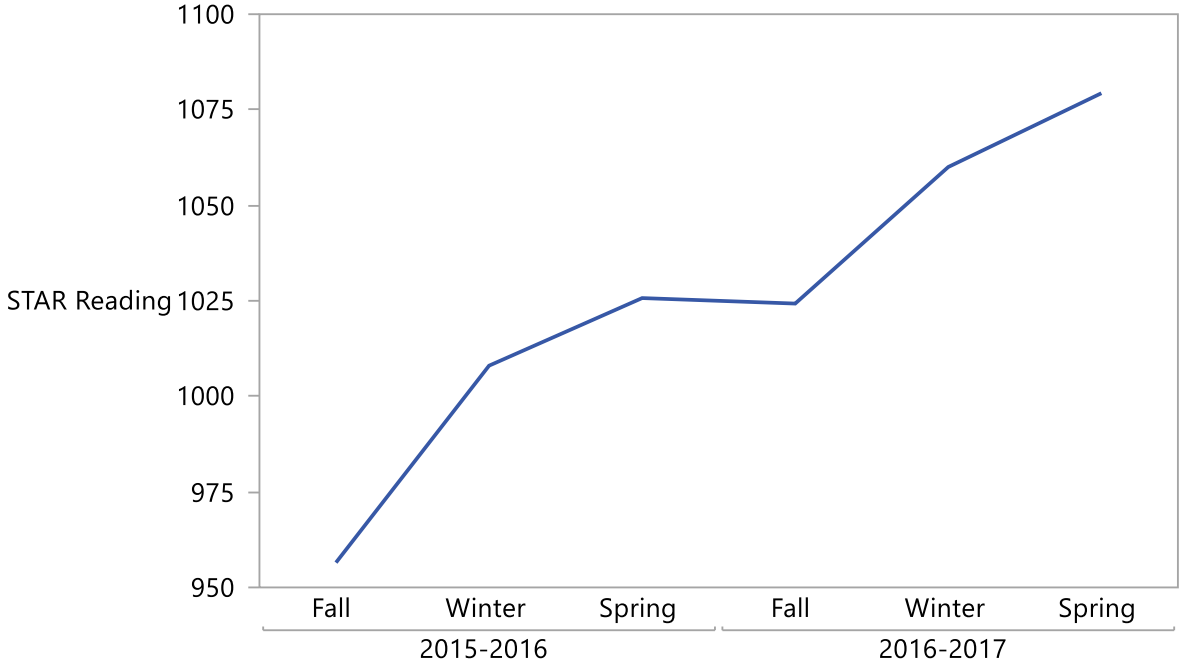
The N's are small for the last three seasons of STAR math assessments (Table 6). Students are usually recommended to take the STAR math assessment before the MCA, which leads to a smaller number of students taking the STAR math assessment at their 11th grade. So, that explains about 300 lesser students taking the STAR math assessment during the year 2016-2017. The false positive rates and false negative rates are not accurate for the last three seasons since the N's are small. Besides that, the cutoff scores for these three seasons will also be less reliable.

Table 6: False positive and false negative rate for each logistic regression model to predict MCA Math proficiency (probability cutoff at 0.75)

STAR Math Assessment	False Positive Rate	False Negative Rate	N
Fall 2014-2015	10%	17%	556
Winter 2014-2015	6%	17%	537
Spring 2014-2015	9%	15%	527
Fall 2015-2016	7%	16%	600
Winter 2015-2016	8%	17%	586
Spring 2015-2016	5%	18%	547
Fall 2016-2017	n/a	2%	180
Winter 2016-2017	n/a	3%	142
Spring 2016-2017	n/a	2%	138

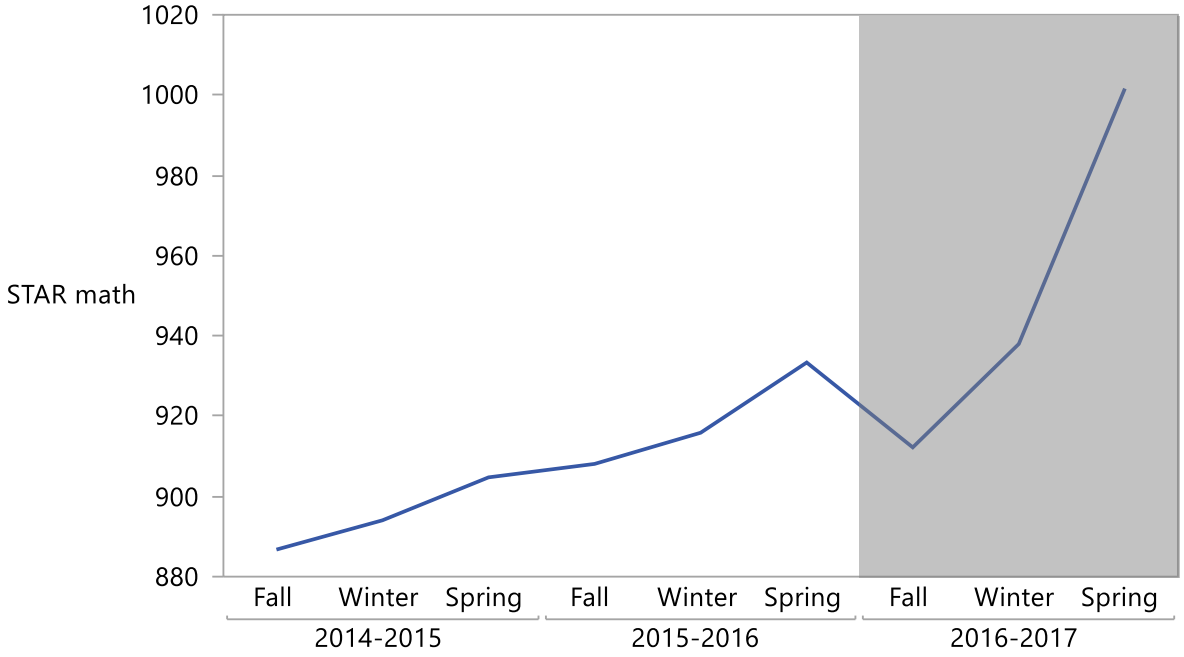
Since the probability cutoff at 75% or 0.75 is selected, students scored below the expected STAR scores to achieve the 75% chance of MCA proficiency will be predicted as non-proficient. Students have to score on the line or above to be predicted as MCA reading proficient during their 10th grade (Figure 3). Overall, it shows an increasing trend but there is a slight decrease from Spring 2015-2016 to Fall 2016-2017. There is a slight decrease on the predicted STAR reading score after students return to school after the summer break.

Figure 3: STAR reading scores at 75% MCA proficiency



The grey shaded area represents the 3 seasons with small sample sizes or smaller amounts of students who completed the STAR math during the seasons (Figure 4).

Figure 4: STAR math scores at 75% MCA proficiency



The last three seasons were removed to show the trend of STAR math scores because they are less accurate due to small sample sizes. The overall predicted STAR math scores at 75% probability of MCA math proficiency increase (Figure 5).

Figure 5: STAR math scores at 75% MCA proficiency (2 years)

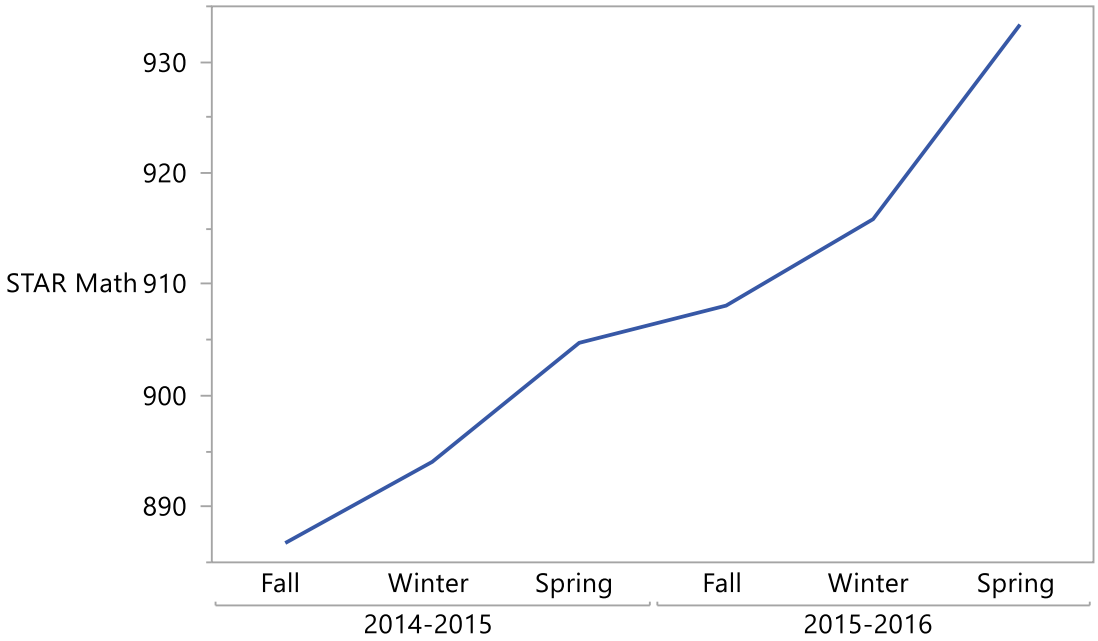
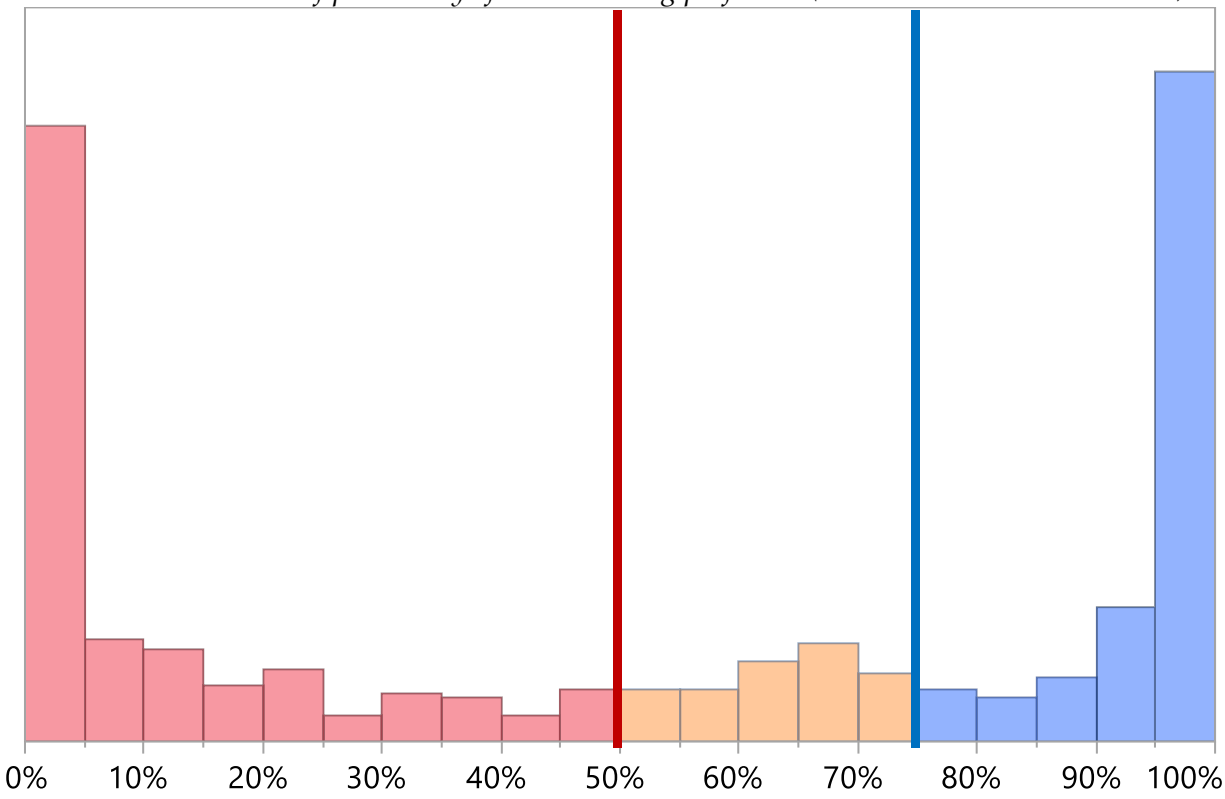


Figure 6: Distribution chart of probability of MCA reading proficient (Fall 2015-2016 STAR model)



Students' probability on MCA proficiency can be calculated using Formula 1 after they completed the STAR assessment. Then students can be categorized to three groups, which are students in high risk, students in medium risk, and students on track. When the probability calculated for a student on MCA proficiency is below 50%, this student is in high risk; when the probability calculated is between 50% and 75%, the student is in medium risk; when the probability is above 90%, this student is on track. Figure 6 is the distribution chart of the probability from the logistic regression model using the STAR reading from Fall 2015-2016 to predict students MCA reading proficiency. Each end has a large number of students, approximately 100 in each end, these students have either very low or very high STAR reading scores during Fall 2015-2016 (Figure 6). The students with a very low probability of MCA proficiency might be the students in special education; the students with a very high probability of MCA proficiency might be the college bound students.

Conclusion

Students are in high risk when their STAR scores are less than the 50% probability cutoff, medium risk when their STAR scores are between 50% and 75% probability cutoffs, and on track when their STAR scores are above 75% (Table 3 and 4). However, the last three seasons for the STAR math might be less reliable due to the small sample sizes. Overall, the cutoffs of STAR scores for reading and math are increasing overtime. Although there is a small drop or less improvement after students return from their summer break, the line graphs of the cutoff scores show increasing trends, which means the students are improving since the STAR assessment measures students' progress overtime. Students predicted to be non-proficient required extra support from teachers or the school, especially students with less than a 50% chance of MCA proficiency.

Appendix

Appendix A: False positive rate and false negative rate at different probability cutoffs

Probability cutoff at 0.5		
STAR Reading Assessment	False Positive Rate	False Negative Rate
Fall 2015-2016	13%	11%
Winter 2015-2016	12%	9%
Spring 2015-2016	13%	10%
Fall 2016-2017	10%	8%
Winter 2016-2017	11%	11%
Spring 2016-2017	12%	11%

Probability cutoff at 0.75		
STAR Reading Assessment	False Positive Rate	False Negative Rate
Fall 2015-2016	6%	24%
Winter 2015-2016	6%	21%
Spring 2015-2016	5%	18%
Fall 2016-2017	6%	17%
Winter 2016-2017	7%	17%
Spring 2016-2017	8%	20%

Probability cutoff at 0.9		
STAR Reading Assessment	False Positive Rate	False Negative Rate
Fall 2015-2016	3%	29%
Winter 2015-2016	3%	27%
Spring 2015-2016	1%	22%
Fall 2016-2017	3%	22%
Winter 2016-2017	5%	25%
Spring 2016-2017	5%	27%

Probability cutoff at 0.5		
STAR Math Assessment	False Positive Rate	False Negative Rate
Fall 2014-2015	17%	10%
Winter 2014-2015	15%	8%
Spring 2014-2015	13%	7%
Fall 2015-2016	16%	10%
Winter 2015-2016	14%	10%
Spring 2015-2016	17%	10%
Fall 2016-2017	25%	2%
Winter 2016-2017	20%	1%
Spring 2016-2017	100%	2%

Probability cutoff at 0.75		
STAR Math Assessment	False Positive Rate	False Negative Rate
Fall 2014-2015	10%	17%
Winter 2014-2015	6%	17%
Spring 2014-2015	9%	15%
Fall 2015-2016	7%	16%
Winter 2015-2016	8%	17%
Spring 2015-2016	5%	18%
Fall 2016-2017	0%	2%
Winter 2016-2017	50%	3%
Spring 2016-2017	n/a	2%

Probability cutoff at 0.9		
STAR Math Assessment	False Positive Rate	False Negative Rate
Fall 2014-2015	3%	26%
Winter 2014-2015	2%	24%
Spring 2014-2015	3%	21%
Fall 2015-2016	2%	23%
Winter 2015-2016	5%	23%
Spring 2015-2016	0%	24%
Fall 2016-2017	0%	5%
Winter 2016-2017	100%	4%
Spring 2016-2017	n/a	2%

Appendix B: Data column meaning

Reading Dataset

Column Name	Description
Identifier	Numbers/ Codes to represent/ identify students
Grade	High School Grades
MCA-III GRADE 10 READING TEST 2016-2017 Scale Score	MCA Scale Score; 1050 - 1099 is proficient, 1001 - 1049 is not proficient
STAR Reading Fall 2015-2016 Scale Score	STAR Reading Score in Fall 2015-2016
STAR Reading Winter 2015-2016 Scale Score	STAR Reading Score in Winter 2015-2016
STAR Reading Spring 2015-2016 Scale Score	STAR Reading Score in Spring 2015-2016
STAR Reading Fall 2016-2017 Scale Score	STAR Reading Score in Fall 2015-2016
STAR Reading Winter 2016-2017 Scale Score	STAR Reading Score in Winter 2016-2017
STAR Reading Spring 2016-2017 Scale Score	STAR Reading Score in Spring 2016-2017

Math Dataset

Column Name	Description
Identifier	Numbers/ Codes to represent/ identify students
Grade	High School Grades
MCA-III GRADE 11 MATH TEST 2016-2017 Scale Score	MCA Scale Score; 1150 - 1199 is proficient, 1101 - 1149 is not proficient
STAR Math Fall 2014-2015 Scale Score	STAR Math Score in Fall 2014-2015
STAR Math Winter 2014-2015 Scale Score	STAR Math Score in Winter 2014-2015
STAR Math Spring 2014-2015 Scale Score	STAR Math Score in Spring 2014-2015
STAR Math Fall 2015-2016 Scale Score	STAR Math Score in Fall 2015-2016

STAR Math Winter 2015-2016 Scale Score	STAR Math Score in Winter 2015-2016
STAR Math Spring 2015-2016 Scale Score	STAR Math Score in Spring 2015-2016
STAR Math Fall 2016-2017 Scale Score	STAR Math Score in Fall 2015-2016
STAR Math Winter 2016-2017 Scale Score	STAR Math Score in Winter 2016-2017
STAR Math Spring 2016-2017 Scale Score	STAR Math Score in Spring 2016-2017