



SCS 3251: Statistics for Data Science

Term Report: Analysis of EQAO Scores

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# Analysis of EQAO Scores

## 1. Introduction

The Ontario government established through the Education Quality and Accountability Act of 1996 the EQAO agency for Ontario Schools in response to recommendations from the 1994 Royal Commission on Learning.

The role of the agency is to act as a testing organization with a focus on improving student learning by monitoring students' achievement at key points in their learning.

Standardized tests for elementary students at Grade 3 and 6, and for secondary students at grades 9 and 10 insures all students are being assessed in the same way. This accountability provided clearer and better information about the quality and effectiveness of the province's education program.

Grade 3 and 6 includes an assessment of Reading, Writing and Mathematics; the Grade 9 assesses Mathematics (Academic and Applied) and Grade 10 assesses a literacy test called the Ontario Secondary School Literacy Test (OSSLT).

All students are expected to participate in the assessments so that all students are accounted for and reports are available.

## 2. Collection of Data

We used a dataset from the Government of Ontario's Open Data Directive website at <https://www.ontario.ca/data/school-information-and-student-demographics>

The Open Data Directive gives access to government data by requiring all data to be made public, unless it is of a commercially-sensitive nature.

This is data on all publicly funded schools in Ontario, including school board, school address, GPS location, provincial test results, and student population demographics.

This data is shown as reported by various sources:

- Board School Identification Database (BSID) / Ontario School Information System (OnSIS) as updated/maintained by boards December 2017
- OnSIS 2015-2016 (Student Population)
- Education Quality and Accountability Office (EQAO) (2016-2017)
- Class-size Tracker, 2015-2016
- 2011 National Household Survey (NHS)
- 2015 Tax Filer (T1 Family File)

### 3. Objective of the Study

With this data we thought it would be interesting to hypothesis whether the income and education of the parents affected the student's outcome in passing the EQAO tests in reading, writing and maths at various stages of their schooling.

If true then it puts children of parents with low incomes and education at a disadvantage in their academic achievements, future success and career options.

We would factor in other variables such as enrolment size and percentage of students whose first language is not English, to see if there is any other relationship involved.

Similar studies (1,2) have been done in the past with the American evaluation system of SAT score and family income. The investigation looked at whether the SAT score was affected by the parents ability to pay for their child's SAT prep classes which would help them get better results.

In our case we are investigating the percentage of students at each school who passed the EQAO standard tests **throughout** each stage their schooling, and the relationship to the percentage of parents with low income and the percentage of parents with university education.

#### 3.1 Hypothesis

The hypothesis being put forward and investigated:

Null Hypothesis  $H_0$  : The number of Ontario school students who pass the EQAO standardized tests is independent of the enrolment size, the parents income and level of education, and if the student's first language is not English.

Alternate Hypothesis  $H_a$  : The number of Ontario school students who pass the EQAO standardized tests is dependent on the enrolment size, the parents income and level of education, and if the student's first language is not English.

We will test this hypothesis with an alpha level of 0.05.

## 4. Analysis of the Data

Analysis of the data was critical to the investigation. The raw data from the CSV file was initially viewed in excel format to get a sense and scope of the data. From this it was determined that the grade classification required multiple variations of the school grades. For example: grade 6 included schools with grades ['JK-8', 'JK-6', '6-8', '1-8', '4-8', '5-8', 'K-8', 'K-6'] which was also reflected on the enrolments. Some columns had information related to the schools, such as names, address, public or Catholic, website, and geo-location. Geolocation was used to generate cluster charts and heat maps of all the schools (Appendix C) using the Folium library.

The following is the top 5 Ontario school boards by school count:

	Board Name	count
0	Toronto DSB	589
1	Peel DSB	261
2	Toronto CDSB	213
3	York Region DSB	212
4	Thames Valley DSB	161

Data cleanup was required as there were data values missing or special characters like N/R, SP, ND, etc, in columns where a numeric value was expected. These were converted to NaN and then removed using Pandas notnull function.

The following statistical methods from PANDAS, MATPLOTLIB, STATMODELS and SKLEARN were used in the analysis:

- a) Means, count.
- b) Regression Analysis:
  - i. Ordinary Least Squared
  - ii. Linear Regression
  - iii. Multiple Linear Regression
- c) Train, Test modelling

## 4.1 Data Variables

The **dependent (predictor) and independent (explanatory) variables** for each of the grades in this investigation are as shown in the table below. The variable names were given new labels with shorter names for ease of use during analysis.

Variables	Labels	Grade3	Grade6	Grade9	Grade10
Board Name	Board Name				
School Number	School Number				
Grade Range	Grade Range				
Enrolment	Enrolment	Independent	Independent	Independent	Independent
Percentage of Students Whose First Language Is Not English	NotEnglish	Independent	Independent	Independent	Independent
Percentage of Grade 3 Students Achieving the Provincial Standard in Reading	Reading	Dependent			
Percentage of Grade 3 Students Achieving the Provincial Standard in Writing	Writing	Dependent			
Percentage of Grade 3 Students Achieving the Provincial Standard in Mathematics	Maths	Dependent			
Percentage of Grade 6 Students Achieving the Provincial Standard in Reading	Reading		Dependent		
Percentage of Grade 6 Students Achieving the Provincial Standard in Writing	Writing		Dependent		
Percentage of Grade 6 Students Achieving the Provincial Standard in Mathematics	Maths		Dependent		
Percentage of Grade 9 Students Achieving the Provincial Standard in Academic Mathematics	MathsAcad			Dependent	
Percentage of Grade 9 Students Achieving the Provincial Standard in Applied Mathematics	MathsAppl			Dependent	
Percentage of Students That Passed the Grade 10 OSSLT on Their First Attempt	Osslit				Dependent
Percentage of Children Who Live in Low-Income Households	LowIncomeHome	Independent	Independent	Independent	Independent
Percentage of Students Whose Parents Have Some University Education	EducatedParents	Independent	Independent	Independent	Independent

The **independent variables** are the explanatory features for evaluating the outcome result of the dependent variable. There were two other independent variables which we could have considered, but did not include at this time. They are the '*Percentage of Students Receiving Education Services*' and '*Percentage of Students Identified as Gifted*'. Although very few schools had students identified as gifted, almost all schools had a percentage of students requiring education services.

## 4.2 Sampling Method

To reduce bias we chose Stratified Sampling to sample our data. A random sampling of 10 schools from each school board was selected for each of the Grades we were analyzing. If a school board had less than 10 schools then we automatically picked all the schools for this school board.

We started out with a large dataset of 4,934 schools among 83 school boards, and for example, there were initially 3652 schools for Grade3 students. After data cleanup and removal of rows with NaN we are left with 2185 schools and 65 school boards. Using the school boards to define the strata, from each school board or stratum we then randomly sampled 10 schools.

Same technique was used to obtain randomly sampled schools for grade 6, 9 and 10 schools. This resulted in 483 Grade3 samples, 463 Grade6 samples, 297 Grade9 samples, and 312 Grade10 samples.

We used the **disproportional stratified sampling** in order to get a meaningful sample of schools from a cross section of Ontario. It did not make sense to use the proportional sampling with this dataset because it would have put a higher weight on one or more of the school boards in and around the GTA.

Generally, disproportional sample tend to be less accurate and reliable compared to a stratified sample since mathematical adjustments are done during the analysis of the data.

( Footnote: we looked at just the GTA schools in the Toronto District School Board (TDSB) in a separate analysis to get an understanding of the demographics, and came to the same conclusions found with the all schools in Ontario.)

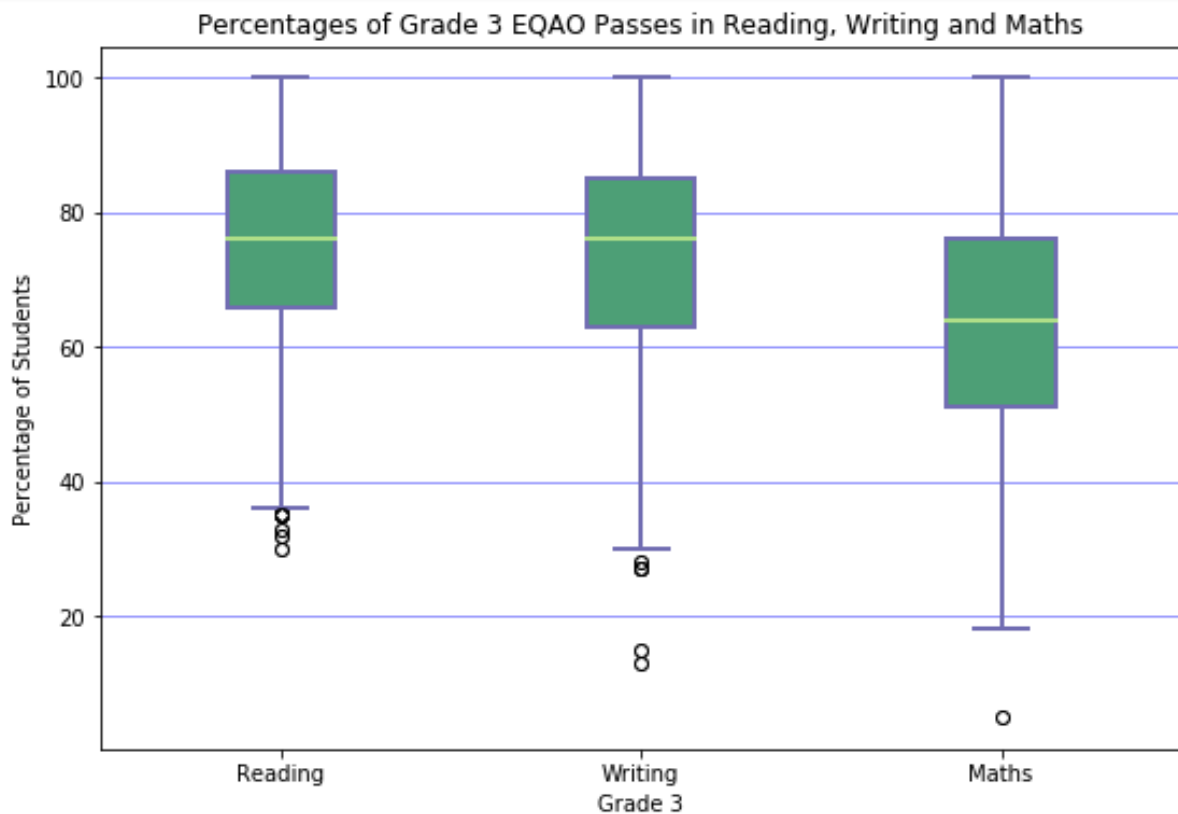
## 5. Results

### 5.1 Means and Counts

Ontario's Education Quality and Accountability Office's (EQAO) 2016/2017 results for students achieving provincial mathematics standard at Grade 3 was lower at 63% than both the reading and writing standards at around 74%.

	School Number	Enrolment	NotEnglish	Reading	Writing	Maths	LowIncomeHome	EducatedParents
count	463.000000	463.000000	463.000000	463.000000	463.000000	463.000000	463.000000	463.000000
mean	530536.885529	382.043197	25.197624	74.632829	73.531317	62.961123	15.242376	24.053305
std	275545.199761	167.162668	26.177176	14.607089	15.705026	17.695189	7.696771	14.657968
min	1104.000000	94.000000	1.500000	30.000000	13.000000	5.000000	2.840000	2.260000
25%	282452.000000	250.500000	5.500000	66.000000	63.000000	51.000000	9.545000	12.940000
50%	619000.000000	343.000000	13.300000	76.000000	76.000000	64.000000	13.630000	20.610000
75%	774190.500000	485.500000	37.850000	86.000000	85.000000	76.000000	19.195000	33.015000
max	868000.000000	1015.000000	98.900000	100.000000	100.000000	100.000000	46.930000	74.390000

### Grade 3 Statistics

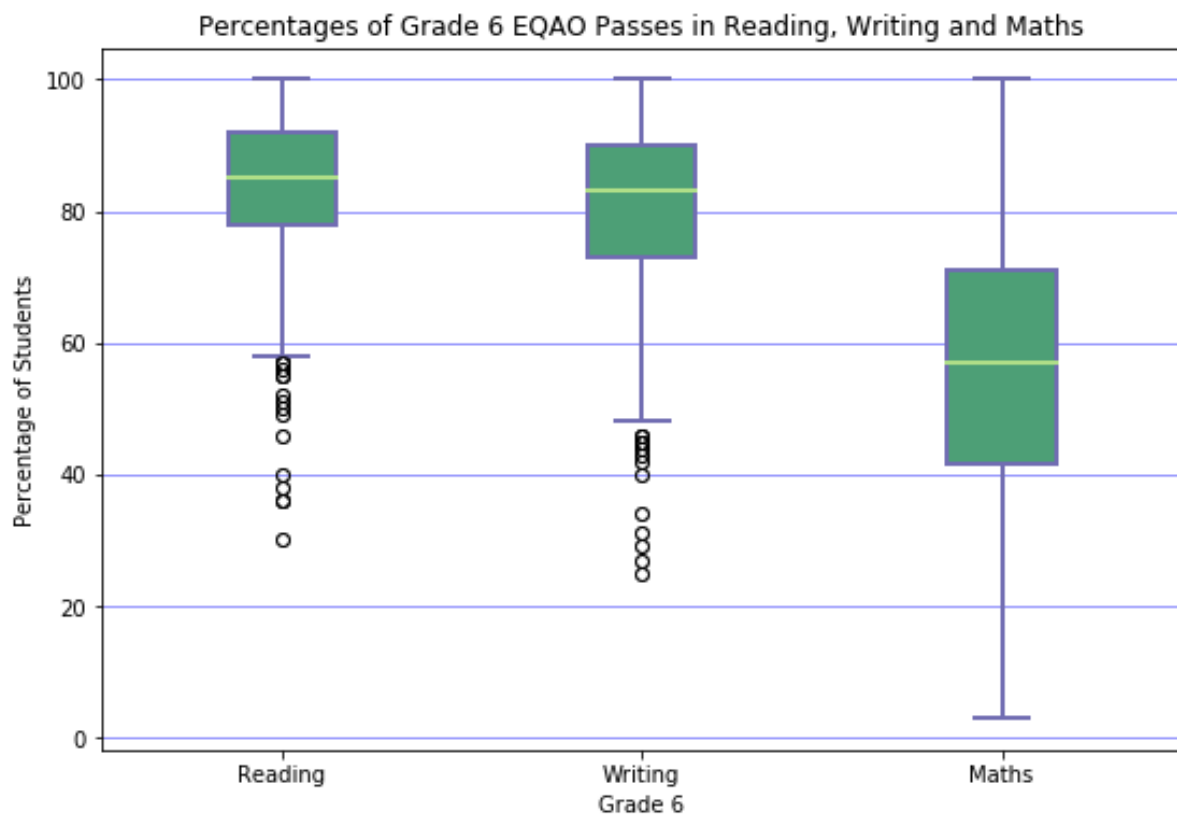




Most tellingly, the results for Grade 6 students dropped significantly, where only 56% met the provincial standard for mathematics. At the same time the provincial standards for reading and writing rose to 83% and 80% respectively.

	School Number	Enrolment	NotEnglish	Reading	Writing	Maths	LowIncomeHome	EducatedParents
count	463.000000	463.000000	463.000000	463.000000	463.000000	463.000000	463.000000	463.000000
mean	533940.831533	395.334773	24.470626	83.447084	79.971922	56.334773	14.868639	25.009093
std	273554.064480	173.262251	25.132788	11.922409	13.782685	20.989644	7.738689	15.437822
min	230.000000	102.000000	1.600000	30.000000	25.000000	3.000000	2.840000	3.770000
25%	283700.500000	263.000000	5.350000	78.000000	73.000000	41.500000	9.265000	12.435000
50%	618396.000000	365.000000	13.200000	85.000000	83.000000	57.000000	13.200000	21.140000
75%	779963.500000	495.000000	36.050000	92.000000	90.000000	71.000000	18.345000	34.790000
max	871029.000000	1093.000000	98.900000	100.000000	100.000000	100.000000	53.390000	75.600000

## Grade 6 Statistics

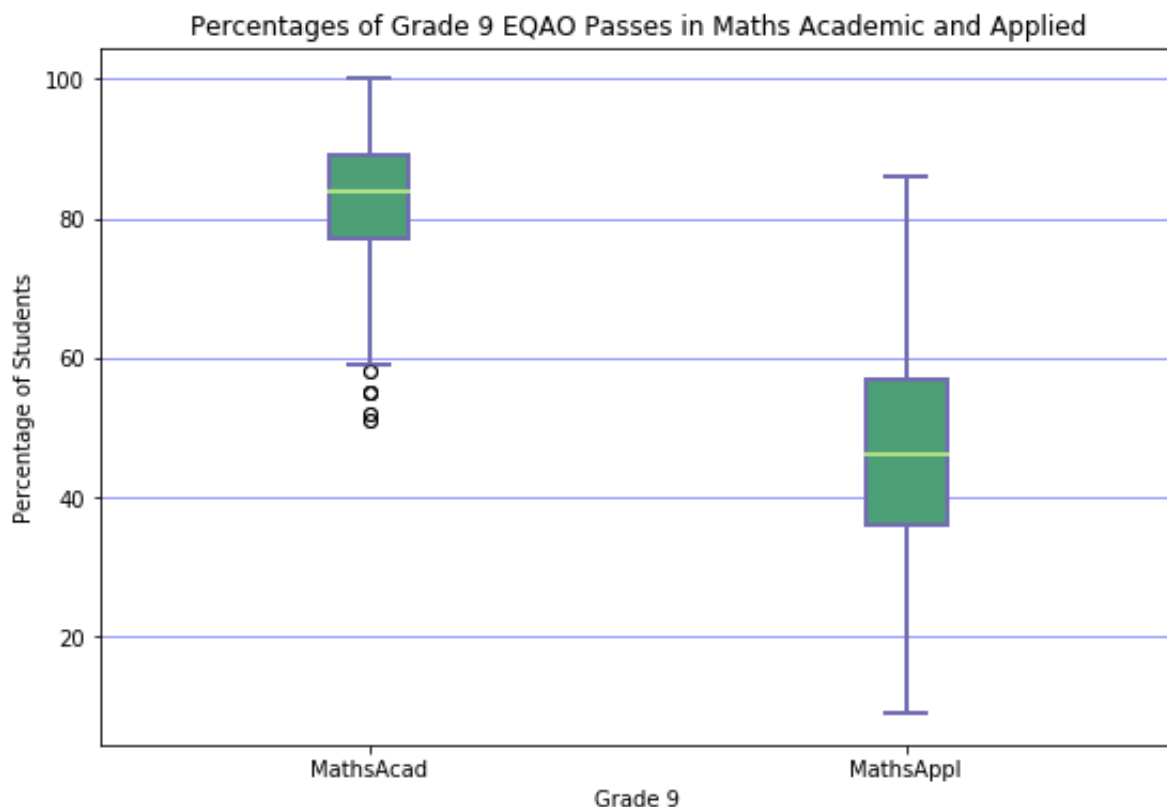


Since reading and writing scores increased during the same time frame, this suggests that external factors such as socioeconomic cannot be blamed for the decline – otherwise, reading scores would have decreased as well.

The declining math scores may be caused by curriculum changes, teaching methods and the math skills of teachers. What's missing here is the affect of the private tutoring industry (Kumon and others alike), the absence of which without doubt the numbers would be a lot worse (3). The backlash from education advocates on this issue has been publicized (5)(6), and the Ministry of Education has taken steps to address this.

	School Number	Enrolment	NotEnglish	MathsAcad	MathsAppl	LowIncomeHome	EducatedParents
count	297.000000	297.000000	297.000000	297.000000	297.000000	297.000000	297.000000
mean	843074.690236	925.959596	23.773401	82.659933	46.498316	18.355556	13.195017
std	93209.346567	374.347583	26.356832	8.992612	15.442816	5.968418	9.693201
min	683922.000000	90.000000	1.000000	51.000000	9.000000	7.840000	1.010000
25%	740454.000000	677.000000	3.800000	77.000000	36.000000	14.200000	5.280000
50%	893455.000000	887.000000	12.300000	84.000000	46.000000	17.330000	10.790000
75%	921408.000000	1155.000000	32.600000	89.000000	57.000000	21.290000	18.300000
max	968729.000000	2000.000000	98.800000	100.000000	86.000000	44.630000	54.140000

## Grade 9 Statistics

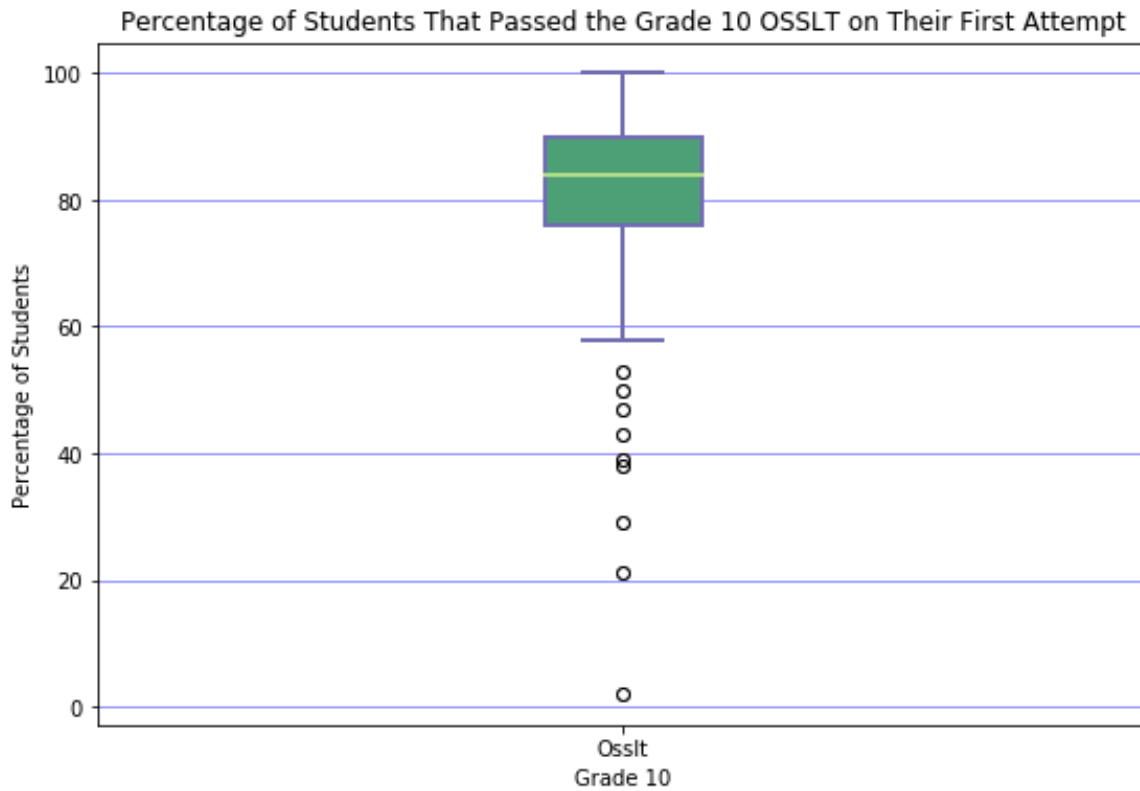


Academic maths improved from a mean of 56 percent at grade 6 to about 82 percent at grade 9.

This suggests that maths teachers in high school are better at teaching academic maths, but it doesn't explain why the applied maths is a dismal mean of 46 percent. Academic courses focus more on abstract applications of concepts, while applied courses focus on the practical. It could be that applied maths is a tougher subject for students to grasp, in which case it should be excluded from EQAO testing. There is no reason not to teach the subject for those who need applied mathematics for advanced mathematics and the sciences.

	School Number	Enrolment	NotEnglish	Osslt	LowIncomeHome	EducatedParents
<b>count</b>	312.000000	312.000000	312.000000	312.000000	312.000000	312.000000
<b>mean</b>	843885.592949	886.432692	24.979487	81.756410	18.822564	12.859776
<b>std</b>	93953.021753	406.178847	27.155107	12.163871	6.151494	9.609583
<b>min</b>	683922.000000	63.000000	1.000000	2.000000	7.840000	1.040000
<b>25%</b>	747778.250000	597.250000	3.800000	76.000000	14.477500	5.367500
<b>50%</b>	893389.000000	851.500000	14.200000	84.000000	17.545000	9.975000
<b>75%</b>	923517.750000	1133.500000	37.625000	90.000000	21.922500	17.522500
<b>max</b>	968729.000000	2042.000000	98.800000	100.000000	44.630000	54.140000

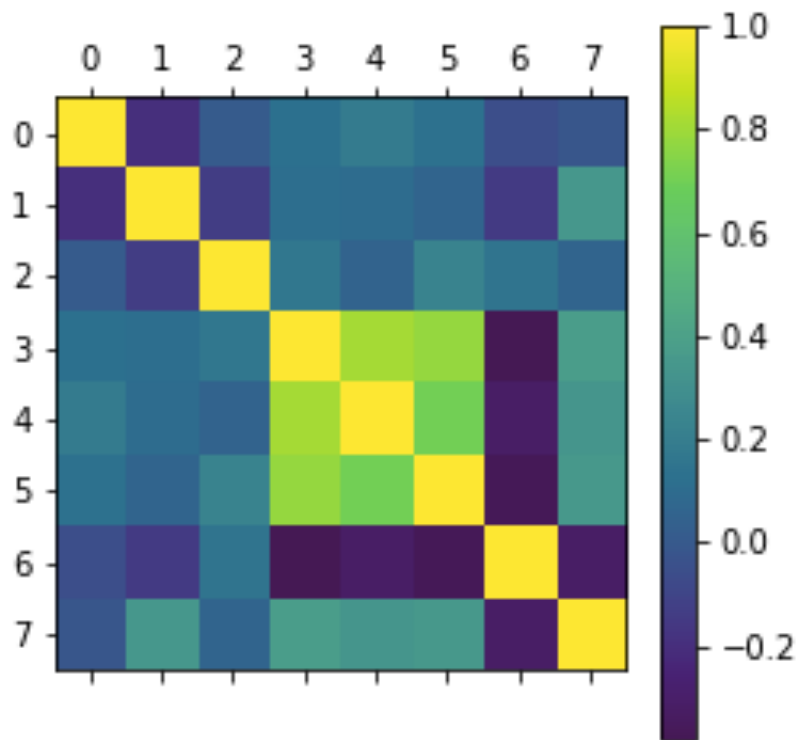
## Grade10 Statistics



With Grade 10 OSSLT, the mean for the percentage of students taking the test who passed is 82%, with the 75% quartile at 90%. This is an incredible high score for literacy which means the schools are doing something right in addressing possible shortfalls in students reading and writing skills. There are outliers in the low range, the school with the lowest OSSLT score is a vocational school with 84% of the students requiring special education services.

## 5.2 Correlation

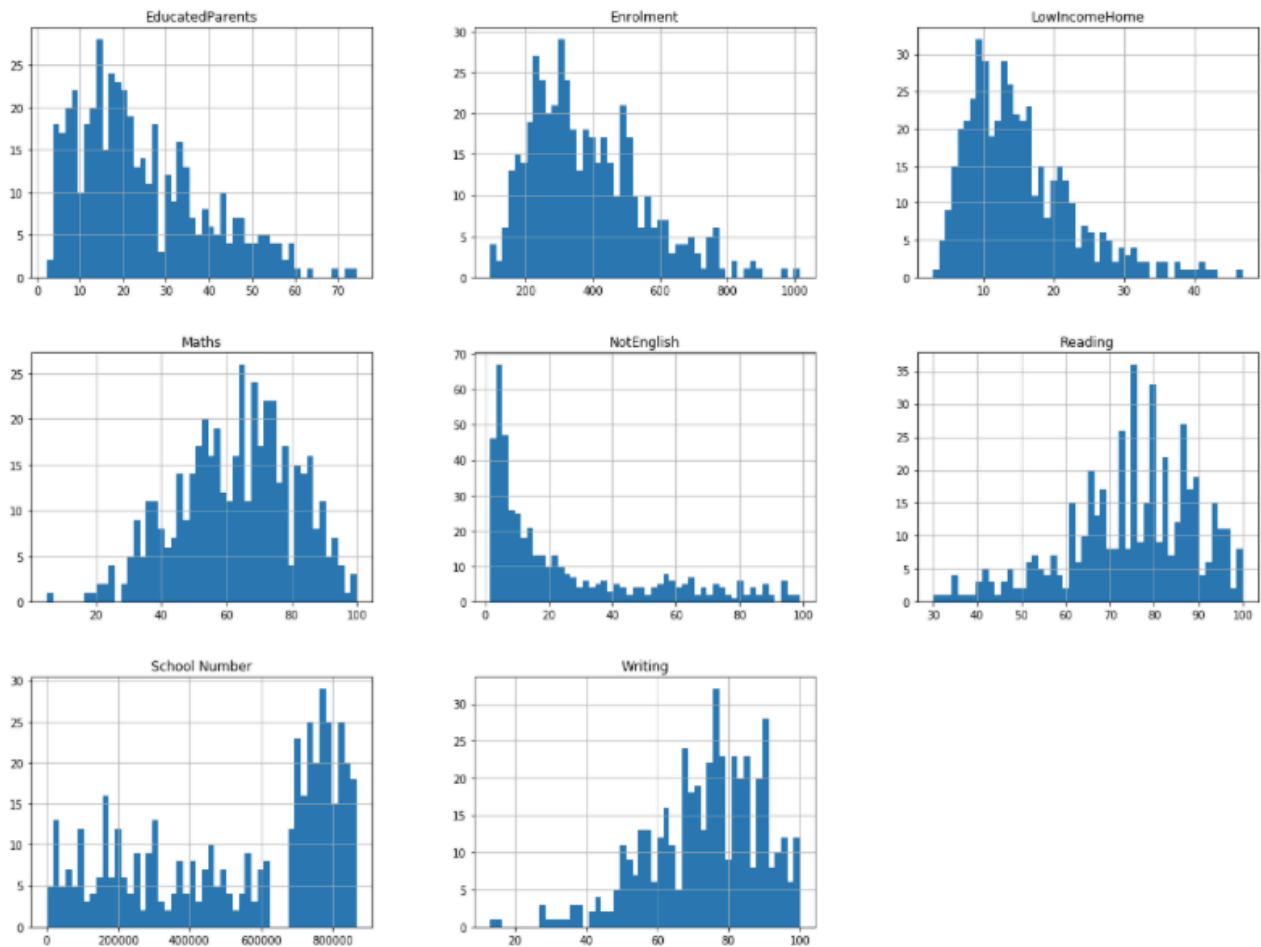
	School Number	Enrolment	NotEnglish	Reading	Writing	Maths	LowIncomeHome	EducatedParents
School Number	1.000000	-0.211859	0.065729	0.140956	0.148346	0.144705	0.048366	-0.001608
Enrolment	-0.211859	1.000000	-0.264408	0.127941	0.094270	0.065374	-0.253186	0.315014
NotEnglish	0.065729	-0.264408	1.000000	0.134604	0.007565	0.187223	0.212003	0.012659
Reading	0.140956	0.127941	0.134604	1.000000	0.810778	0.799246	-0.344821	0.351959
Writing	0.148346	0.094270	0.007565	0.810778	1.000000	0.738979	-0.291379	0.317700
Maths	0.144705	0.065374	0.187223	0.799246	0.738979	1.000000	-0.353019	0.321054
LowIncomeHome	0.048366	-0.253186	0.212003	-0.344821	-0.291379	-0.353019	1.000000	-0.312880
EducatedParents	-0.001608	0.315014	0.012659	0.351959	0.317700	0.321054	-0.312880	1.000000



The colour-coded correlation matrix indicates that there moderate to strong correlation between reading, writing and maths. Enrolment is weak with all the features we are investigating. The strongest correlation is between reading and writing, which goes without saying as they are both closely related.

## 5.3 Histograms

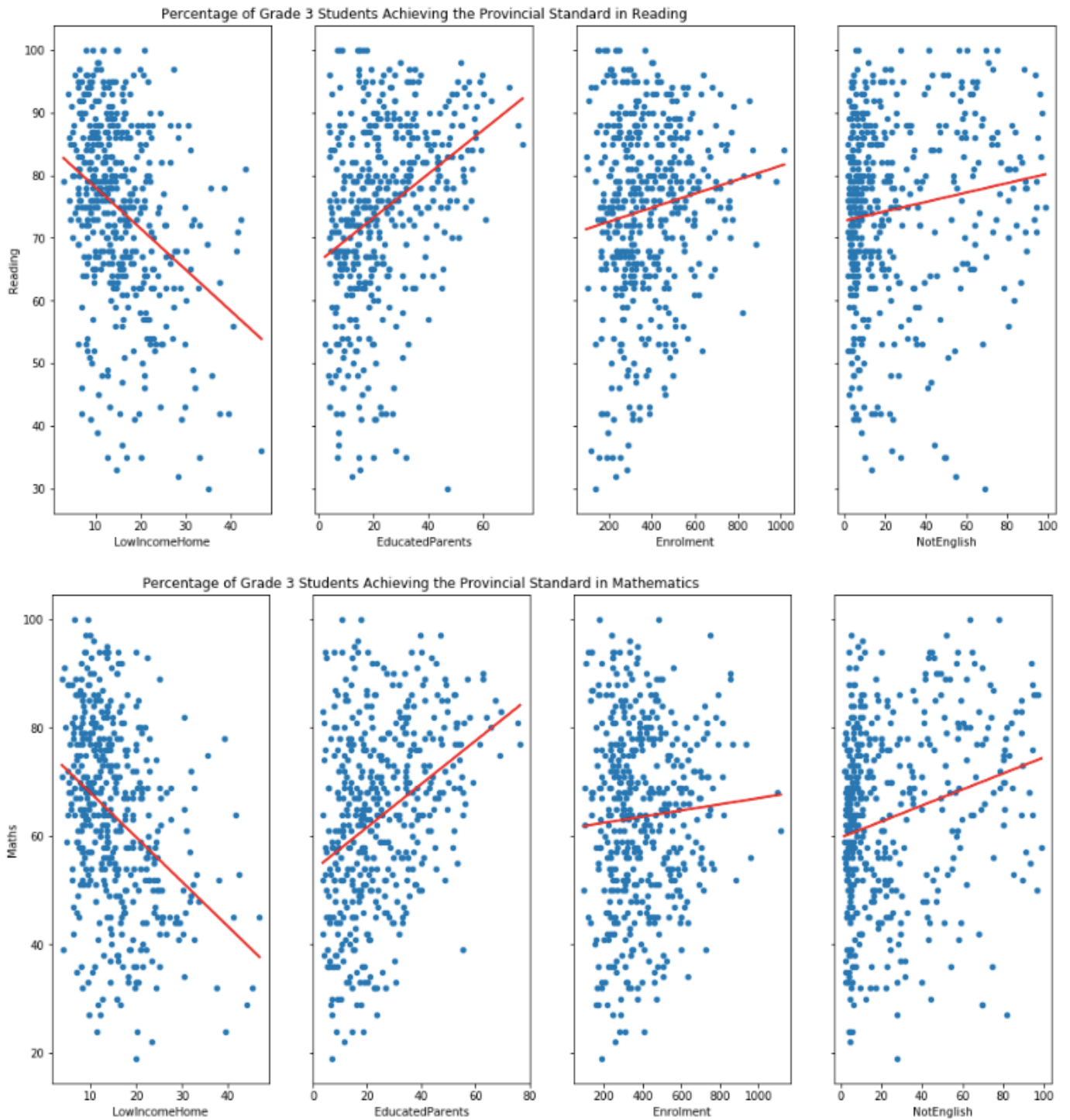
To get some idea for the type of data we are dealing with, a histogram is drawn for each numeric variable.



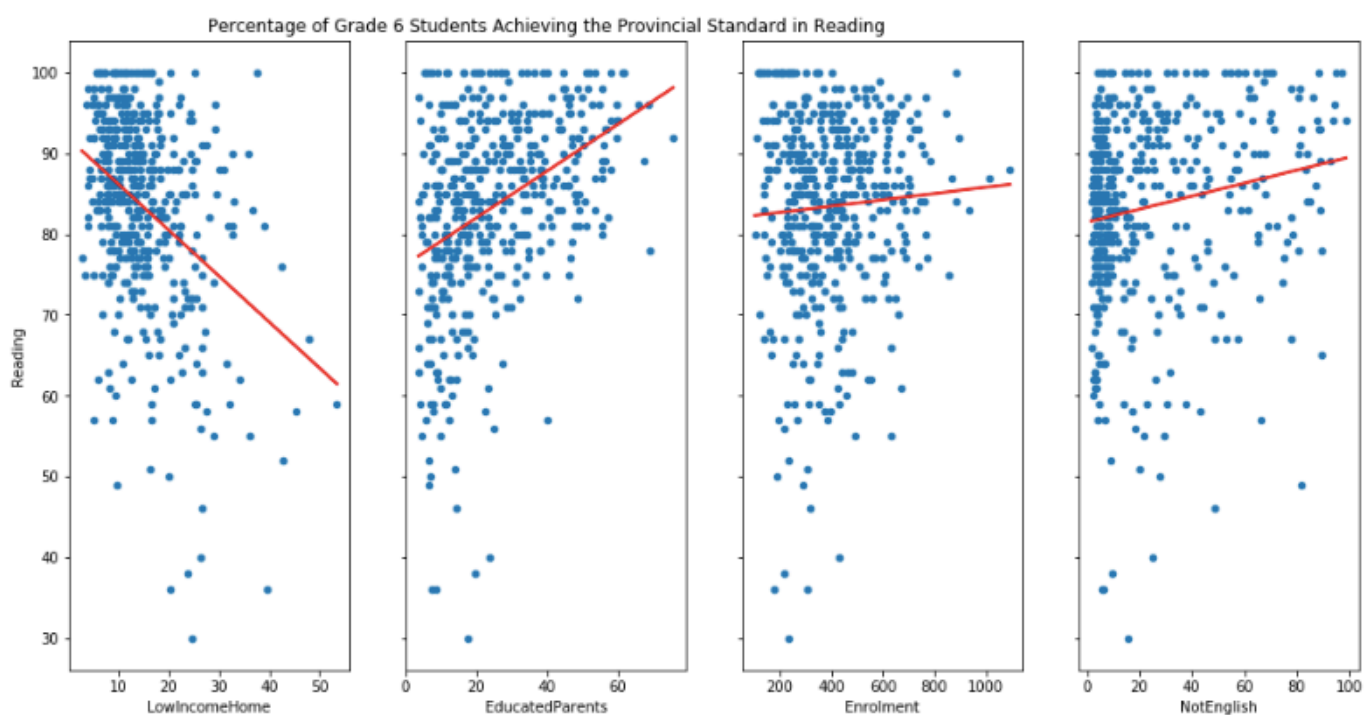
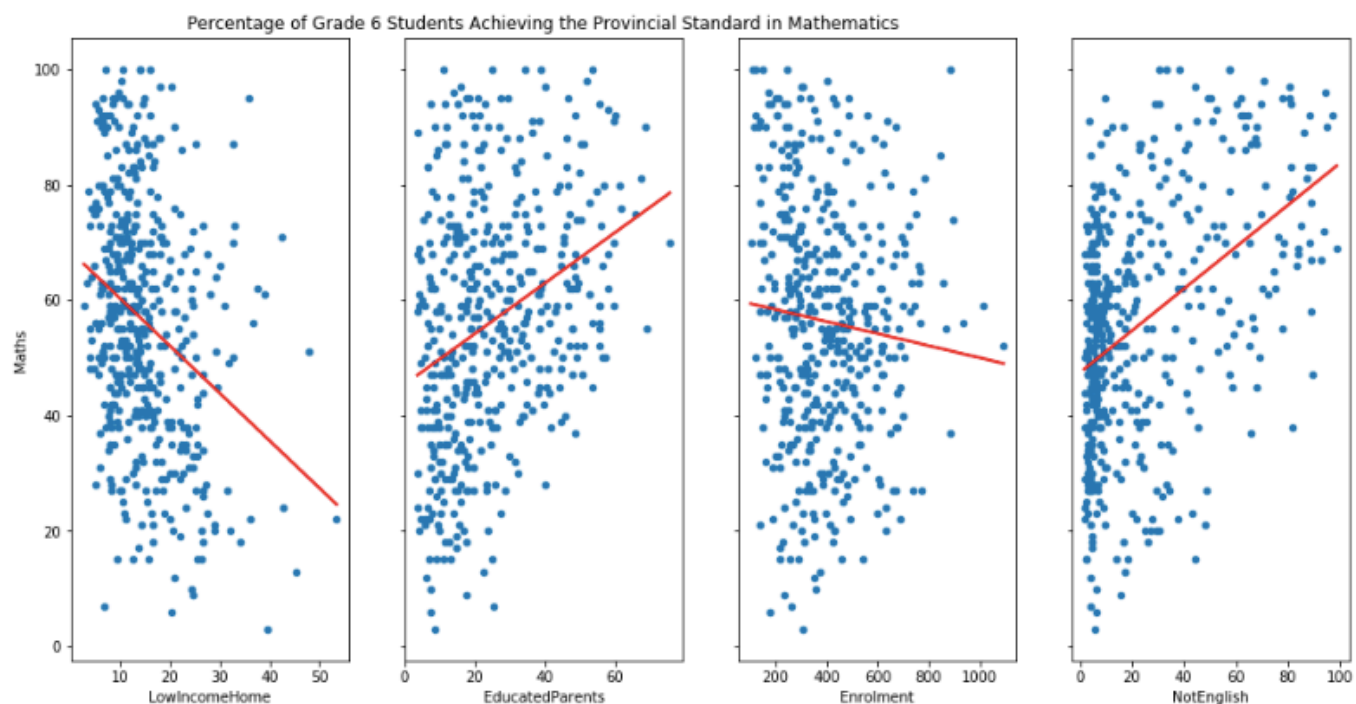
### Grade 3 Histogram Plots

LowIncomeHome and NotEnglish histograms are right skewed distributions, as we would expect. There are very few schools where the percentages of students from low income homes is high, especially in Ontario. The histograms for EducatedParent, Reading, Writing and Maths are normal or near normal distributions. The distributions for Reading and Writing appear to follow very closely with each other.

## 5.4 Scatter Plots and Best Fit Line

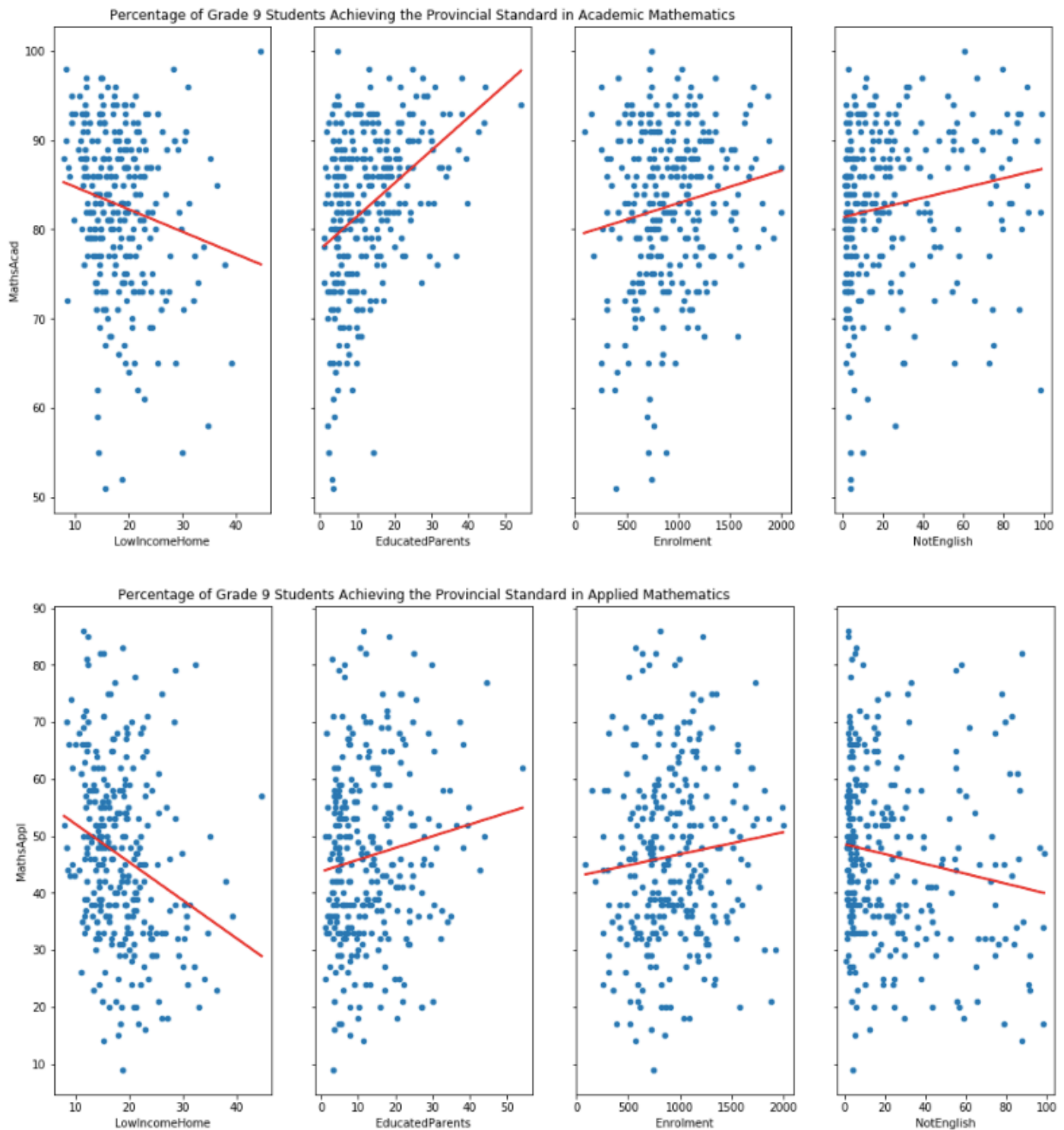


Grade 3 OLS scatter plots with best fit lines

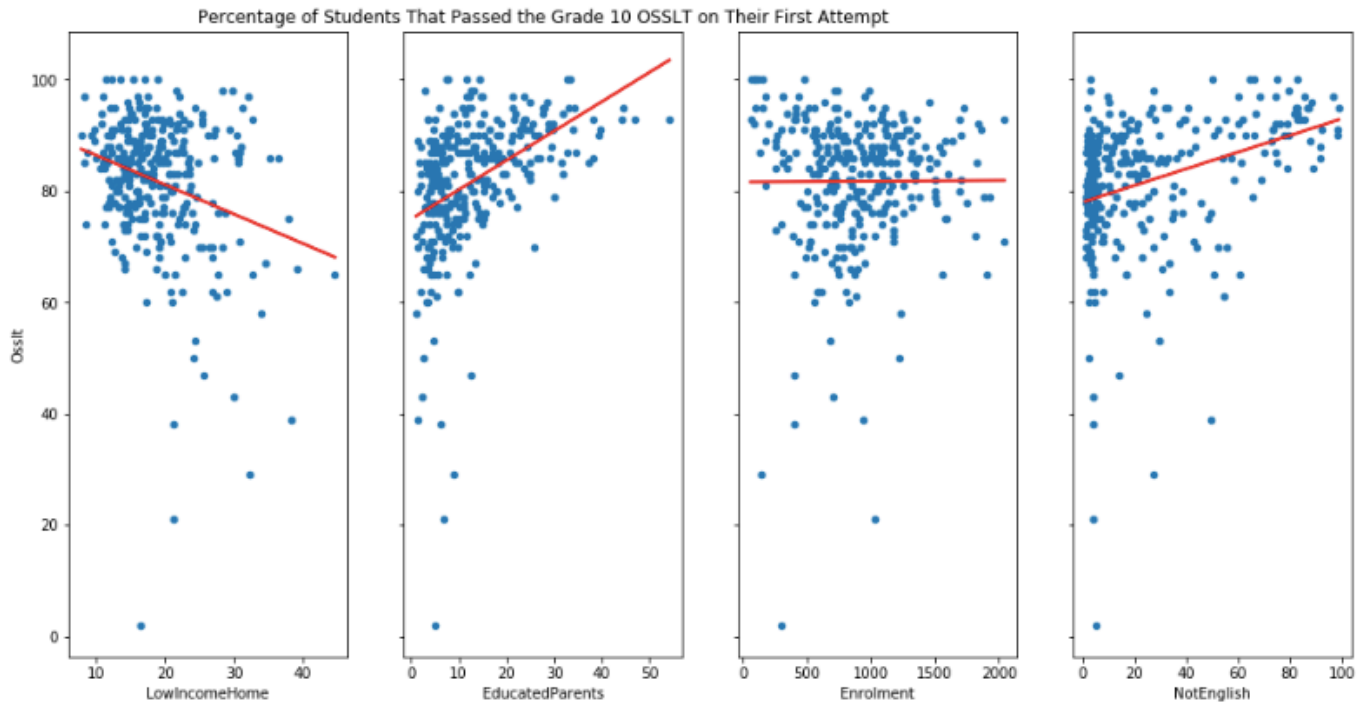


Grade 6 OLS scatter plots with best fit lines





Grade 9 OLS scatter plots and best fit lines



Grade 10 OLS scatter plots and best fit lines

The percentage of grade 3 and grade 6 students passing the EQAO test for Maths appears to have a negative linear relationship with the increase of students that come from a low income home. The higher the number of students from low income homes the lower the average score on the EQAO test.

The percentage of grade 3 and grade 6 students passing the EQAO test for Maths appears to have a positive linear relationship with the increase in the number of students with educated parents. The higher number of students with educated parents the higher the average score on the EQAO test.

These relationship is correlated further with the percentage of students passing Grade 9 Maths Academic and Grade 10 OSSLT literacy tests.

The slope of the linear regression for Grade 3 and Grade 6 Maths with Enrolment and with NotEnglish is almost horizontal indicating there is no obvious relationship between these variables.

With Grade 9 Maths Academic and Enrolment there is a positive linear relationship, the slope is more than seen with Grade3 and 6 students, which possibly indicates that larger enrolments is happening in Grade 9 schools which has some effect on the maths scores. Possibly Grade 9 maths score for students is an important indicator for applying for university and college, and therefore the effort is reflected in the higher pass percentages. We can see from the regression charts that 'NotEnglish' (Percentage of

Students Whose First Language Is Not English) does not have any significant affect on the percentages for Reading and Writing scores. However the regression charts show a strong positive correlation with Maths, which implies that students from non-English foreign countries do favourably better in Maths. This implies there is a higher emphasis in teaching maths in other countries.

## 5.5 Ordinary Least Squared

The ordinary least squared (OLS) models for simple linear and multiple linear regression were tabulated for each of features being investigated. The results are shown in **appendix B**.

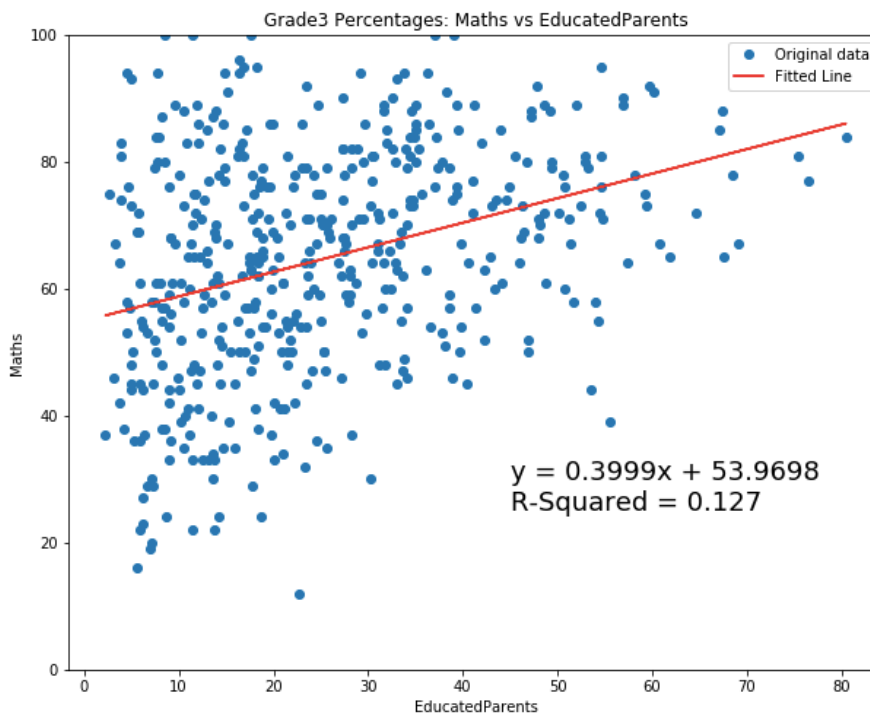
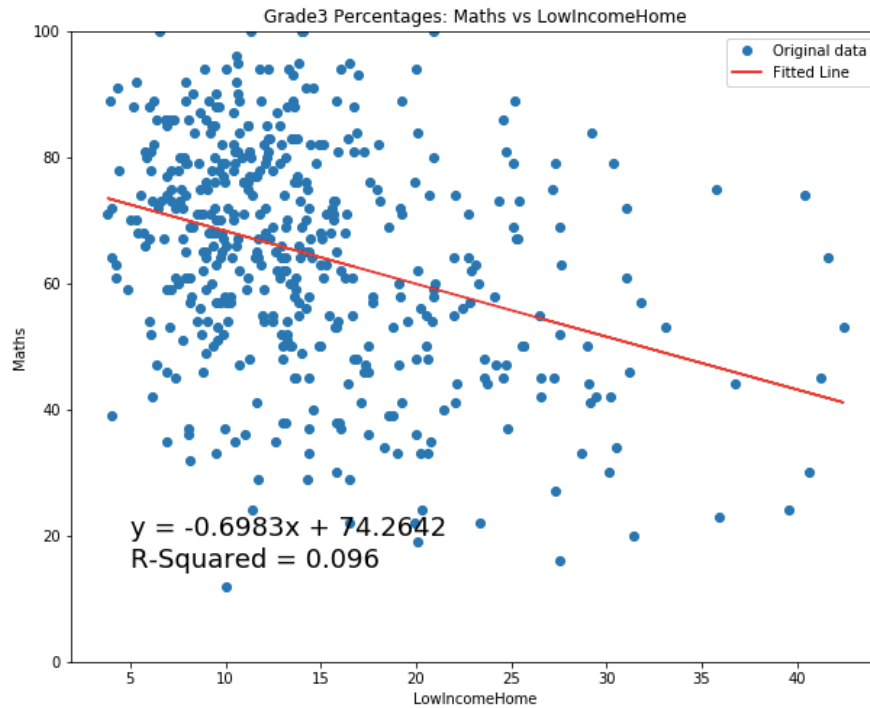
For Grade 3, an R-squared of 0.004 indicates there is very little that explains the variations in the Maths score and Enrolment. The R-squared values of 0.237 and 0.222 in multiple regression indicates there is an association with Maths and Reading and the exploratory variables, most specifically with LowIncomeHome and EducatedParents. The P-value remains high in all regression tests.

For Grade 6, the R-squared of 0.000 and 0.008 for Maths and Reading indicated no discernible association with Enrolment. For multi-variants the R-squared values for 0.383 and 0.247 moderately explains the variations in the EQAO scores for Maths and Reading.

For Grade 9 and 10, the R-squared in 0.183 and 0.312 for the multi-variant regression indicates that there is some variations in the EQAO scores that can be explained by the explanatory variables. The R-squared value of 0.000 and a p-value of 0.953 for Enrolment at Grade 10 indicates that Enrolment has no discernible association with the number of students passing the EQAO OSSLT.

## 5.6 Simple Linear Regression

A closer look at the simple linear regression.



The best fit line for Maths and LowIncomeHome, the slope indicates that for each 1% increase of student population from LowIncomeHome there is an almost 0.7% decrease in percentage of students that pass the Maths test.

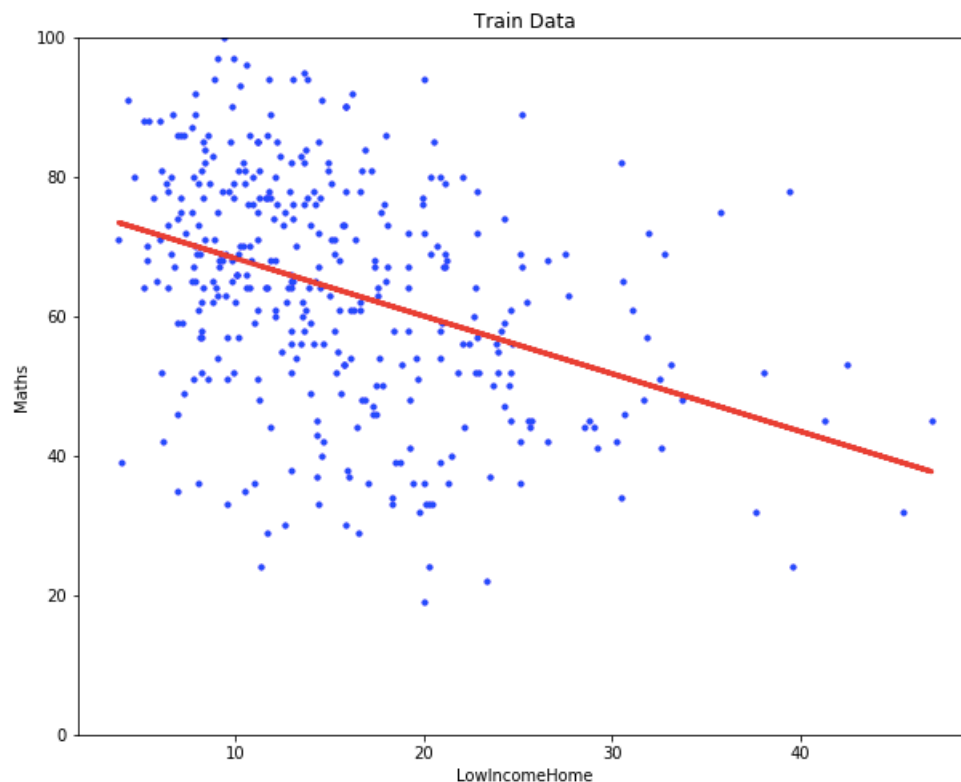
Conversely, with in 1% increase in EducatedParents there is a 0.4% increase in percentage of students that pass the Maths test. It appears that younger students from low income home seem to have a harder time doing well in school. This may be due to a number of factors; such as poor nutrition and lack of opportunities in enhancing their well-being through recreation and other extra-curricular activities.

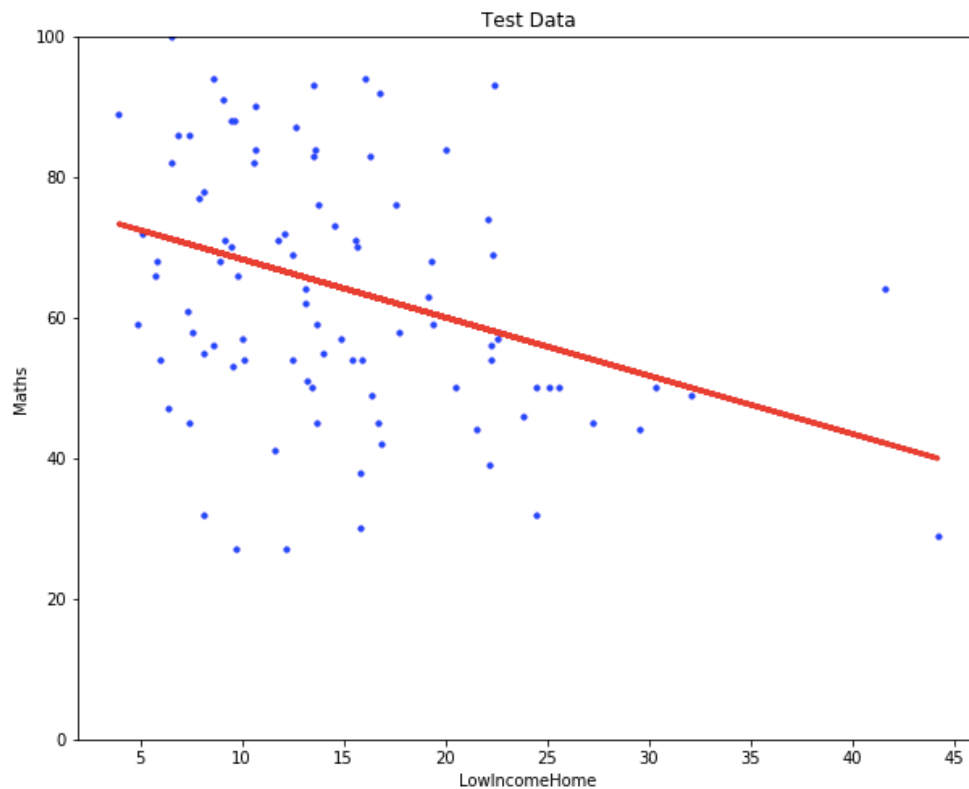
## 5.7 Multiple Linear Regression

Multiple linear regression with forward selection was done using the OLS model. Most significant was that Enrolment had very little to contribute to the variations in the dependent variables. This was surprising when you consider Enrolment as being a factor in class sizes per teacher. However in all the cases, there were only slightly lower or no changes to the R-squared values when Enrolment was included as an independent variable.

## 5.8 Train-Test Modelling

A model was trained using `train_test_split` and the `LinearRegression` model from `SkLearn`. The data sampled the Grade 3 LowIncomeHome and Maths, to come up with the following results:





Other models were also considered, namely RandomForestRegressor and the GradientBoostRegressor from SKLearn. Results of which are shown here:

Model	R-Squared	RMSE
LinearRegression	0.0180	16.4823
RandomForestRegressor	-0.5329	20.5932
GradientBoostRegressor	-0.2630	18.6926

The lower RMSE of 16.4823 compared to the other models indicates that LinearRegression is the best model, and the positive R-Squared value confirms this.

## 6. Conclusion

We ran a mix of simple and multiple regressions across all the dependent and independent variables, and across all grades in our dataset. The resulting p-values in the regression summaries were consistent across each grade. The amount of regressions and consistency in results gives us some measure of confidence in our conclusion.

A small p-value of 0.000 for the majority of features means that there is stronger evidence in favour of the alternative hypothesis.

In conclusion, we reject the null hypothesis in favour of the alternate hypothesis; that the student's success in EQAO tests is dependent on the parents income and education level. There is no relationship with enrolment size and EQAO scores, and only moderate positive association with students the percentage of students whose first language is not English.

## 7. References

- 1) Leilan Sheu & Sara Dada - "Impact of Household Income on Standardized Test Scores", web: [https://smartech.gatech.edu/bitstream/handle/1853/54227/impact\\_of\\_income\\_on\\_test\\_scores\\_dadasheu.pdf](https://smartech.gatech.edu/bitstream/handle/1853/54227/impact_of_income_on_test_scores_dadasheu.pdf)
- 2) Bishwa Silwak - "SAT Score and Family Income", web: [http://www.academia.edu/8925347/SAT\\_Score\\_and\\_Family\\_Income](http://www.academia.edu/8925347/SAT_Score_and_Family_Income)
- 3) Ian Cooper - "Solve Ontario's Math Education Problem For All Students, Not Just The Rich", web: [https://www.huffingtonpost.ca/ian-cooper/ontario-math-education-problem\\_a\\_23408209/](https://www.huffingtonpost.ca/ian-cooper/ontario-math-education-problem_a_23408209/)
- 4) A tale of two schools: The correlation between income and education in Toronto. Globe and Mail web article <https://www.theglobeandmail.com/news/national/time-to-lead/a-tale-of-two-schools-the-correlation-between-income-and-education/article15463950/>
- 5) Ontario's math system is broken. So why isn't the government fixing it? Globe and Mail web article <https://www.theglobeandmail.com/opinion/ontarios-math-system-is-broke-so-why-isnt-the-government-fixing-it/article31664784/>
- 6) Ontario addresses math score decline amid worry from parents, educators. Globe and Mail web article <https://www.theglobeandmail.com/news/national/half-of-ontarios-grade-6-students-fail-to-meet-provincial-math-standards/article31636338/>



## Appendix A : Complete List of Data from Ontario Schools

Variables	Labels
Board Number	
Board Name	Board Name
School Number	School Number
School Name	
School Type	
School Special Condition Code	
School Level	
School Language	
Grade Range	Grade Range
P.O. Box	
Street	
Municipality	
City	
Province	
Postal Code	
Phone Number	
Fax Number	
School Website	
Board Website	
Enrolment	Enrolment
Latitude	
Longitude	
Percentage of Students Whose First Language Is Not English	NotEnglish
Percentage of Students Whose First Language Is Not French	

<b>Variables</b>	<b>Labels</b>
Percentage of Students Who Are New to Canada from a Non-English Speaking Country	
Percentage of Students Who Are New to Canada from a Non-French Speaking Country	
Percentage of Students Identified as Gifted	
Percentage of Students Receiving Special Education Services	
Percentage of Grade 3 Students Achieving the Provincial Standard in Reading	Reading
Change in Grade 3 Reading Achievement Over Three Years	
Percentage of Grade 3 Students Achieving the Provincial Standard in Writing	Writing
Change in Grade 3 Writing Achievement Over Three Years	
Percentage of Grade 3 Students Achieving the Provincial Standard in Mathematics	Maths
Change in Grade 3 Mathematics Achievement Over Three Years	
Percentage of Grade 6 Students Achieving the Provincial Standard in Reading	Reading
Change in Grade 6 Reading Achievement Over Three Years	
Percentage of Grade 6 Students Achieving the Provincial Standard in Writing	Writing
Change in Grade 6 Writing Achievement Over Three Years	
Percentage of Grade 6 Students Achieving the Provincial Standard in Mathematics	Maths
Change in Grade 6 Mathematics Achievement Over Three Years	
Percentage of Grade 9 Students Achieving the Provincial Standard in Academic Mathematics	MathsAcad
Change in Grade 9 Academic Mathematics Achievement Over Three Years	
Percentage of Grade 9 Students Achieving the Provincial Standard in Applied Mathematics	MathsAppl
Change in Grade 9 Applied Mathematics Achievement Over Three Years	
Percentage of Students That Passed the Grade 10 OSSLT on Their First Attempt	OsslT

<b>Variables</b>	<b>Labels</b>
<b>Change in Grade 10 OSSLT Literacy Achievement Over Three Years</b>	
<b>Percentage of Children Who Live in Low-Income Households</b>	<b>LowIncomeHome</b>
<b>Percentage of Students Whose Parents Have Some University Education</b>	<b>EducatedParents</b>
<b>Percentage of JK-Grade 3 Classes With 20 Students or Fewer</b>	
<b>Percentage of JK-Grade 3 Classes With 23 Students or Fewer</b>	
<b>Extract Date</b>	

## Appendix B: Regression Results

	R-Squared	Adj R-Squared	Coefficient	P-Value	SE	Observations
<b>GRADE 3</b>						
Maths, LowIncomeHome	0.125	0.125	-0.8116	0.000	0.100	483
Maths, EducatedParents	0.103	0.101	0.3876	0.000	0.053	483
Maths, Enrolment	<b>0.004</b>	0.002	0.0069	<b>0.160</b>	0.005	483
Maths, NotEnglish	0.035	0.033	0.031	0.000	0.031	483
Maths, LowIncomeHome, EducatedParents	0.174	0.170	-0.6437, 0.2818	0.000, 0.000	0.103, 0.054	483
Maths, LowIncomeHome, EducatedParents, Enrolment	0.181	0.176	-0.6793, 0.3104, -0.0096	0.000, 0.000, <b>0.046</b>	0.104, 0.056, 0.005	483
Maths, LowIncomeHome, EducatedParents, Enrolment, NotEnglish	<b>0.237</b>	0.230	-0.7913, 0.2628, -0.0025, 0.1697	0.000, 0.000, <b>0.596</b> , 0.000	0.102, 0.054, 0.005, 0.029	483
Reading, LowIncomeHome	0.119	0.117	-0.6544	0.000	0.083	483
Reading, EducatedParents	0.124	0.122	0.3507	0.000	0.043	483
Reading, Enrolment	0.016	0.014	0.0112	0.006	0.004	483
Reading, NotEnglish	0.018	0.016	0.0751	0.004	0.026	483
Reading, LowIncomeHome, EducatedParents	0.185	0.181	-0.4938, 0.2696	0.000, 0.000	0.084, 0.044	483
Reading, LowIncomeHome, EducatedParents, Enrolment	0.186	0.180	-0.5024, 0.2765, -0.0023	0.000, 0.000, <b>0.557</b>	0.085, 0.046, 0.004	483
Reading, LowIncomeHome, EducatedParents, Enrolment, NotEnglish	<b>0.222</b>	0.215	-0.5772, 0.2448, 0.0024, 0.1134	0.000, 0.000, <b>0.550</b> , 0.000	0.085, 0.045, 0.004, 0.024	483

### Grade 3 Regression Results

	R-Squared	Adj R-Squared	Coefficient	P-Value	SE	Observations
<b>GRADE 6</b>						
Maths, LowIncomeHome	0.105	0.103	-0.9015	0.000	0.122	463
Maths, EducatedParents	0.113	0.111	0.4686	0.000	0.061	463
Maths, Enrolment	<b>0.000</b>	-0.002	0.0010	<b>0.871</b>	0.006	463
Maths, NotEnglish	0.171	0.169	0.3429	0.000	0.035	463
Maths, LowIncomeHome, EducatedParents	0.161	0.158	-0.6524, 0.3527	0.000, 0.000	0.127, 0.064	463
Maths, LowIncomeHome, EducatedParents, Enrolment	0.188	0.183	-0.7144, 0.4377, -0.0230	0.000, 0.000, 0.000	0.126, 0.066, 0.006	463
Maths, LowIncomeHome, EducatedParents, Enrolment, NotEnglish	<b>0.383</b>	0.377	-0.9772, 0.3320, -0.0130, 0.3798	0.000, 0.000, 0.014, 0.000	0.122, 0.059, 0.005, 0.032	463
Reading, LowIncomeHome	0.145	0.143	-0.6001	0.000	0.068	463
Reading, EducatedParents	0.112	0.110	0.2638	0.000	0.035	463
Reading, Enrolment	<b>0.008</b>	0.006	0.0066	0.054	0.003	463
Reading, NotEnglish	0.032	0.030	0.0839	0.000	0.022	463
Reading, LowIncomeHome, EducatedParents	0.191	0.187	-0.4731, 0.1798	0.000, 0.000	0.071, 0.035	463
Reading, LowIncomeHome, EducatedParents, Enrolment	0.197	0.192	-0.4904, 0.2034, -0.0064	0.000, 0.000, 0.057	0.071, 0.037, 0.003	463
Reading, LowIncomeHome, EducatedParents, Enrolment, NotEnglish	<b>0.247</b>	0.241	-0.5662, 0.1729, -0.0035, 0.1096	0.000, 0.000, <b>0.285</b> , 0.000	0.070, 0.037, 0.003, 0.020	463

### Grade 6 Regression Results

	R-Squared	Adj R-Squared	Coefficient	P-Value	SE	Observations
<b>GRADE 9</b>						
MathsAcad, LowIncomeHome	0.028	0.024	-0.2503	0.004	0.087	297
MathsAcad, EducatedParents	0.159	0.156	0.3696	0.000	0.050	297
MathsAcad, Enrolment	0.023	0.020	0.0037	0.008	0.001	297
MathsAcad, NotEnglish	0.026	0.022	0.0547	0.006	0.020	297
MathsAcad, LowIncomeHome, EducatedParents	0.170	0.165	-0.1648, 0.3545	0.043, 0.000	0.081, 0.050	297
MathsAcad, LowIncomeHome, EducatedParents, Enrolment	0.171	0.162	-0.1636, 0.3472, 0.0006	0.044, 0.000, <b>0.656</b>	0.081, 0.53, 0.001	297
MathsAcad, LowIncomeHome, EducatedParents, Enrolment, NotEnglish	<b>0.183</b>	0.172	-0.2407, 0.2924, 0.0015, 0.0458	0.007, 0.000, <b>0.277</b> , 0.036	0.089, 0.058, 0.001, 0.022	297
<b>GRADE 10</b>						
Ossit, LowIncomeHome	0.071	0.068	-0.5281	0.000	0.108	312
Ossit, EducatedParents	0.174	0.171	0.5278	0.000	0.065	312
Ossit, Enrolment	<b>0.000</b>	-0.003	0.0001	<b>0.953</b>	0.002	312
Ossit, NotEnglish	0.112	0.109	0.1499	0.000	0.024	312
Ossit, LowIncomeHome, EducatedParents	0.210	0.204	-0.3810, 0.4800	0.000, 0.000	0.102, 0.065	312
Ossit, LowIncomeHome, EducatedParents, Enrolment	0.224	0.217	-0.3862, 0.5241, -0.0038	0.000, 0.000, 0.016	0.101, 0.067, 0.002	312
Ossit, LowIncomeHome, EducatedParents, Enrolment, NotEnglish	<b>0.312</b>	0.303	-0.6456, 0.3188, -0.0002, 0.1608	0.000, 0.0.000, <b>0.888</b> , 0.000	0.104, 0.071, 0.002, 0.026	312

### *Grade 9 and 10 Regression Results*

## Appendix C: MarkerClusters and HeatMaps

Ontario Grade 3 schools

