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FSA Performance Gap Analysis

Public Schools vs. Private Schools

Presented to:

BC Ministry of Education

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BRITISH COLUMBIA | Ministry of Education

Executive Summary

This report investigates the Foundation Skills Assessment (FSA) performance of fourth and seventh grade students in British Columbia from 2007/2008 to 2014/2015 to determine whether a discrepancy exists between private and public schools.

The FSA assesses students in the areas of numeracy, reading, and writing. As such, each subject is examined separately between private and public schools. The dataset pertaining to FSA performance were obtained via the BC Data Catalogue and was further examined by their shape of distributions through histograms and boxplots. Following this, t-tests were conducted in order to identify whether a significant difference exists in average FSA performance between private and public schools.

From the results of the gap analysis, we have identified a discrepancy between FSA performance of private and public schools in all three subject areas. It is found that private schools do in fact outperform public schools in all three subjects, thus contributing to their high annual school ranking by the Fraser Institute.

Gap Analysis

Methodology

The primary objective of the gap analysis is to identify whether a difference of significance exists between private and public schools based on the Foundation Skills Assessment (FSA) results. For each FSA subject and grade level, summary statistics, histograms, and a boxplot were generated using SAS EG to show the distribution of the data. An F-test was conducted to analyze variance in the data to determine which t-test to use (Pooled or Satterthwaite). Using the appropriate one-sided two-sample t-test, we were able to conclude with 95% confidence that private schools do outperform public schools on the FSA. If such a difference exists, our next objective is to outline a strategy for performing a root cause analysis. The results of our findings will be submitted to the BC Ministry of Education.

Data Source

The results of the Grades 4 and 7 BC FSA in Numeracy, Reading and Writing from 2007/2008 to 2014/2015 have been taken from the BC Data Catalogue at the following link:

https://catalogue.data.gov.bc.ca/dataset/bc-schools-foundation-skills-assessment-fsa-

The BC Data Catalogue provides two datasets available for use:

(1) **FSA_ALL_STUDENTS_HIST.xlsx** – This dataset includes both writers and non-writers of the FSA.
(2) **FSA_WRITERS_ONLY_HIST.xlsx** – This dataset focuses only on those who wrote the FSA.

Because our scope is limited to only analyzing the performance of students based on FSA results, we will utilize the second dataset as it is most relevant to our objective. It should be noted that there may be sampling bias due to the students who did not write the FSA and as such, it may not accurately represent the student population.

Data Analysis

The dataset provides a comprehensive breakdown of student performance based on multiple criteria such as gender, participation rate, school district and others that are irrelevant for analysis. The following filters are going to be applied:

(1) SCHOOL LEVEL only under DATA_LEVEL column (to eliminate the total results per district and province)
(2) ALL STUDENTS only under SUB__POPULATION column (to eliminate results breakdown based on gender, participation rate, and disabilities)

The dataset contains quite a few dependent samples. For instance, the public school students who wrote the Grade 4 FSA in 2007/2008 will be almost identical to the public school students who wrote the Grade 7 FSA in 2010/2011. It should be noted that students may transfer from public to private schools (or vice versa) between writing the Grade 4 and 7 FSA, but this is assumed to not result in sampling bias. To eliminate the potential correlation effect between samples, two separate analyses were performed on Grade 4 and Grade 7 scores.

FSA Numeracy Performance

- **Grade 4:**
  Examining Exhibit A, we determined that the p-value of the F-test is less than 5%, meaning that the variance between the normal distributions of independent and public schools are unequal. Therefore, the Satterthwaite T-test should be utilized. The p-value of the Satterthwaite T-test is less than 5%, meaning that the mean FSA scores for private and public are significantly different with a difference of 57.20.

  Therefore, it is interpreted that:
  - A performance gap exists between private and public schools in their FSA numeracy performance scores for 4th graders
  - We are 95% confident that 4th graders in private schools outperform public schools in the numeracy section of the FSA test by 57.20 on average

- **Grade 7:**
  Examining Exhibit B, we determined that the p-value of the F-test is less than 5%, meaning that the variance between the normal distributions of independent and public schools are unequal. Therefore, the Satterthwaite T-test should be utilized. The p-value of the Satterthwaite T-test is less than 5%, meaning that the mean FSA scores for private and public are significantly different with a difference of 57.18.

  Therefore, it is interpreted that:
  - A performance gap exists between private and public schools in their FSA numeracy performance scores for 7th graders
  - We are 95% confident that 7th graders in private schools outperform public schools in the numeracy section of the FSA test by 57.18 on average
  - Comparing the difference between average Grade 4 and 7 FSA scores, the gap remains nearly the same

FSA Reading Performance

- **Grade 4**

  Examining Exhibit C, we determined that the p-value of the F-test is less than 5%, meaning that the variance between the normal distributions of independent and public schools are unequal. Therefore, the Satterthwaite T-test should be utilized. The p-value of the Satterthwaite T-test is less than 5%, meaning that the mean FSA scores for private and public are significantly different with a difference of 48.50.

  Therefore, it is interpreted that:
  - A performance gap exists between private and public schools in their FSA reading performance scores for 4th graders
  - We are 95% confident that 4th graders in private schools outperform public schools in the reading section of the FSA test by 48.50 on average

- **Grade 7**

  Examining Exhibit D, we determined that the p-value of the F-test is less than 5%, meaning that the variance between the normal distributions of independent and public schools are unequal. Therefore, the Satterthwaite T-test should be utilized. The p-value of the Satterthwaite T-test is less than 5%, meaning that the mean FSA scores for private and public are significantly different with a difference of 48.85.

  Therefore, it is interpreted that:
  - A performance gap exists between private and public schools in their FSA reading performance scores for 7th graders
  - We are 95% confident that 7th graders in private schools outperform public schools in the reading section of the FSA test by 48.85 on average
  - Comparing the difference between average Grade 4 and 7 FSA scores, the gap remains nearly the same

FSA Writing Performance

- **Grade 4**

  Examining Exhibit E, we determined that the p-value of the F-test is less than 5%, meaning that the variance between the normal distributions of independent and public schools are unequal. Therefore, the Satterthwaite T-test should be utilized. The p-value of the Satterthwaite T-test is less than 5%, meaning that the mean FSA scores for private and public are significantly different with a difference of 1.23.

  Therefore, it is interpreted that:
  - A performance gap exists between private and public schools in their FSA writing performance scores for 4th graders

- We are 95% confident that 4th graders in private schools outperform public schools in the writing section of the FSA test by 1.23 on average

- **Grade 7**
  Examining Exhibit F, we determined that the p-value of the F-test is less than 5%, meaning that the variance between the normal distributions of independent and public schools are unequal. Therefore, the Satterthwaite T-test should be utilized. The p-value of the Satterthwaite T-test is less than 5%, meaning that the mean FSA scores for private and public are significantly different with a difference of 1.38.

  Therefore, it is interpreted that:
  - A performance gap exists between private and public schools in their FSA writing performance scores for 7th graders
  - We are 95% confident that 7th graders in private schools outperform public schools in the writing section of the FSA test by 1.38 on average
  - Comparing the difference between average Grade 4 and 7 FSA scores, the gap increased by approximately 12%

Root Cause Analysis

The potential root causes for the gap in FSA performance between public and private schools include (but are not limited to):

1. **Class sizes -** Private schools in general are known to have better teacher-to-student ratios due to smaller class sizes whereas overcrowding is a known issue to exist in public schools. Smaller class sizes allow students to obtain greater individual time with teachers to better meet their needs.

2. **FSA preparation -** Private schools may be incentivized to dedicate relatively more time to the FSA in order to rank highly in FSA performance. They need to maintain and improve their reputation to retain students and attract future enrollment. Public schools, however, do not share this incentive because these factors are not applicable as funding is secured from the government, and therefore are not as highly motivated to prepare for the FSA. In addition, the socioeconomic backgrounds of students from private schools may offer an advantage over public schools, as their households have more income which could result in additional resources such as tutoring.

3. **Faculty and staff qualifications -** Private schools have greater flexibility in terms of employee selection and budget to hire qualified faculty and staff. They can offer competitive salaries and benefits which attracts higher quality faculty and staff. This is in

contrast to public schools which are unionized, resulting in barriers in a school's ability to restructure their faculty and staff, learning and development programs, and curriculum.

4. **Learning environment -** In general, private schools are known to enforce a more disciplined learning environment which may be generally beneficial for student performance. Public schools, however, may be far more lenient and therefore less disciplined as they foster a "no student left behind" policy. In such policy, teachers prioritize improving the bottom performers as opposed to continuing to improve top performers.

In order to determine whether the root causes above are indeed drivers of the phenomenon of interest, the following data should be collected:

1. The teacher-to-student ratio for the average class in each private and public schools
2. The average budgeted amount or time from school districts that are allocated towards FSA preparation provided to students in each private and public schools
3. The average household amount spent on tutoring, learning materials, and other educational expenses
4. The degree of effort and resources placed into the hiring and training process of staff and faculty in each private and public schools
5. The amount of parent-teacher feedback (absentees, dropouts, grades, goals. etc.) in each private and public schools

This data can be collected via surveying and sampling. The data collected can then be analyzed using multiple regression to determine if and which of the explanatory variable(s) may be correlated with the difference in FSA performance between private and public schools. Similarly, we would examine the p-values of the variables to determine whether they are statistically significant, and then determine whether they are also practically significant. Furthermore, even if the variables are highly correlated, we would need to conduct additional statistical analysis to determine if these relationships are causal in reality.

Conclusion

This report has identified a discrepancy in FSA performance between B.C. private and public schools between 2007/2008 to 2014/2015. The gap analysis presents with 95% confidence that private schools outperform public schools in all three subjects of the FSA. The potential root causes for the existing gap have been discussed along with possible methods to perform a complete root cause analysis. The analysis conducted in this report provides a general response to the central question and requires further investigation for a fully conclusive answer.

Exhibits

Exhibit A – Distribution of Numeracy Score and T-Table for 4th Graders

PUBLIC_OR_INDEPENDENT	N	Mean	Std Dev	Std Err	Minimum	Maximum
BC Independent School	1300	536.7	64.7226	1.7951	208.6	693.1
BC Public School	7218	479.5	47.8306	0.563	103.5	755.5
Diff (1-2)		57.2009	50.7718	1.5297		

PUBLIC_OR_INDEPENDENT	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
BC Independent School		536.7	533.2	540.2	64.7226	62.3269	67.3112
BC Public School		479.5	478.4	480.6	47.8306	47.063	48.624
Diff (1-2)	Pooled	57.2009	54.2023	60.1996	50.7718	50.0207	51.546
Diff (1-2)	Satterthwaite	57.2009	53.5108	60.8911			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	8516	37.39	<.0001
Satterthwaite	Unequal	1564.4	30.41	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	1299	7217	1.83	<.0001

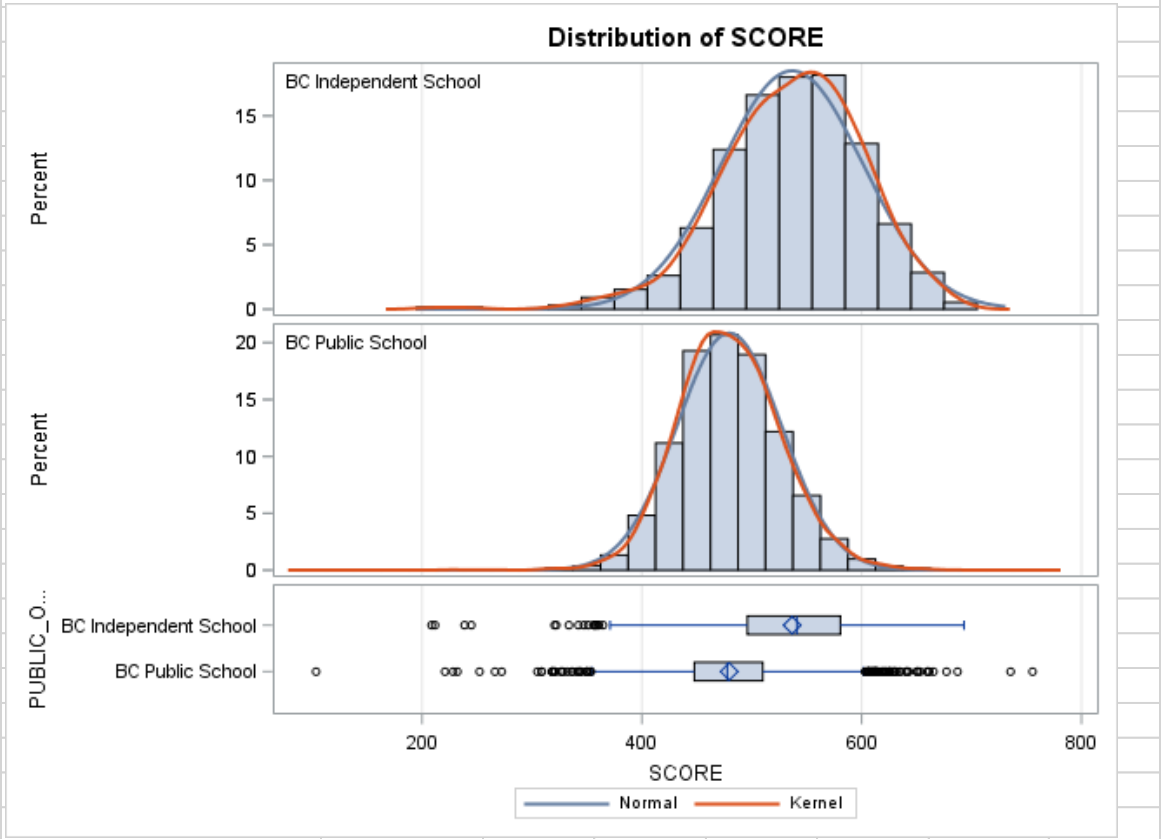

Exhibit B – Distribution of Numeracy Score and T-Table for 7th Graders

PUBLIC_OR_INDEPENDENT	N	Mean	Std Dev	Std Err	Minimum	Maximum
BC Independent School	1223	532.1	61.0146	1.7447	207.2	691.5
BC Public School	5574	474.9	51.7155	0.6927	179.5	671.3
Diff (1-2)		57.1809	53.5071	1.6896		

PUBLIC_OR_INDEPENDENT	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
BC Independent School		532.1	528.7	535.6	61.0146	58.6887	63.5337
BC Public School		474.9	473.6	476.3	51.7155	50.773	52.6938
Diff (1-2)	Pooled	57.1809	53.8688	60.493	53.5071	52.6225	54.4222
Diff (1-2)	Satterthwaite	57.1809	53.499	60.8628			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	6795	33.84	<.0001
Satterthwaite	Unequal	1628.7	30.46	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	1222	5573	1.39	<.0001

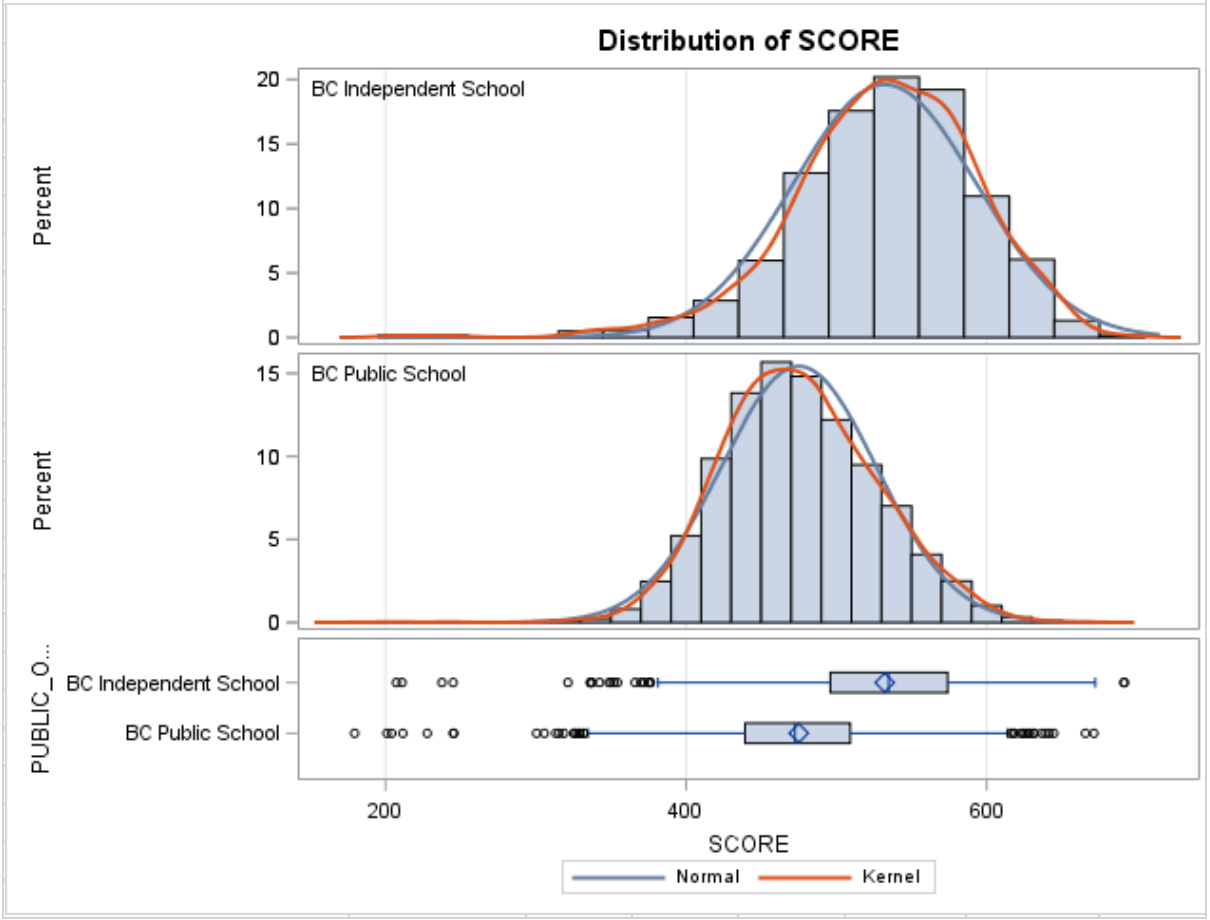

Exhibit C – Distribution of Reading Score and T-Table for 4th Graders

PUBLIC_OR_INDEPENDENT	N	Mean	Std Dev	Std Err	Minimum	Maximum
BC Independent School	1303	530.9	55.1481	1.5278	200	699.7
BC Public School	7226	482.4	42.9268	0.505	72.7813	1420.7
Diff (1-2)		48.5057	45.0081	1.3546		

PUBLIC_OR_INDEPENDENT	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
BC Independent School		530.9	527.9	533.9	55.1481	53.1091	57.3512
BC Public School		482.4	481.4	483.4	42.9268	42.2382	43.6384
Diff (1-2)	Pooled	48.5057	45.8503	51.1611	45.0081	44.3426	45.6939
Diff (1-2)	Satterthwaite	48.5057	45.3496	51.6618			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	8527	35.81	<.0001
Satterthwaite	Unequal	1598.6	30.15	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	1302	7225	1.65	<.0001

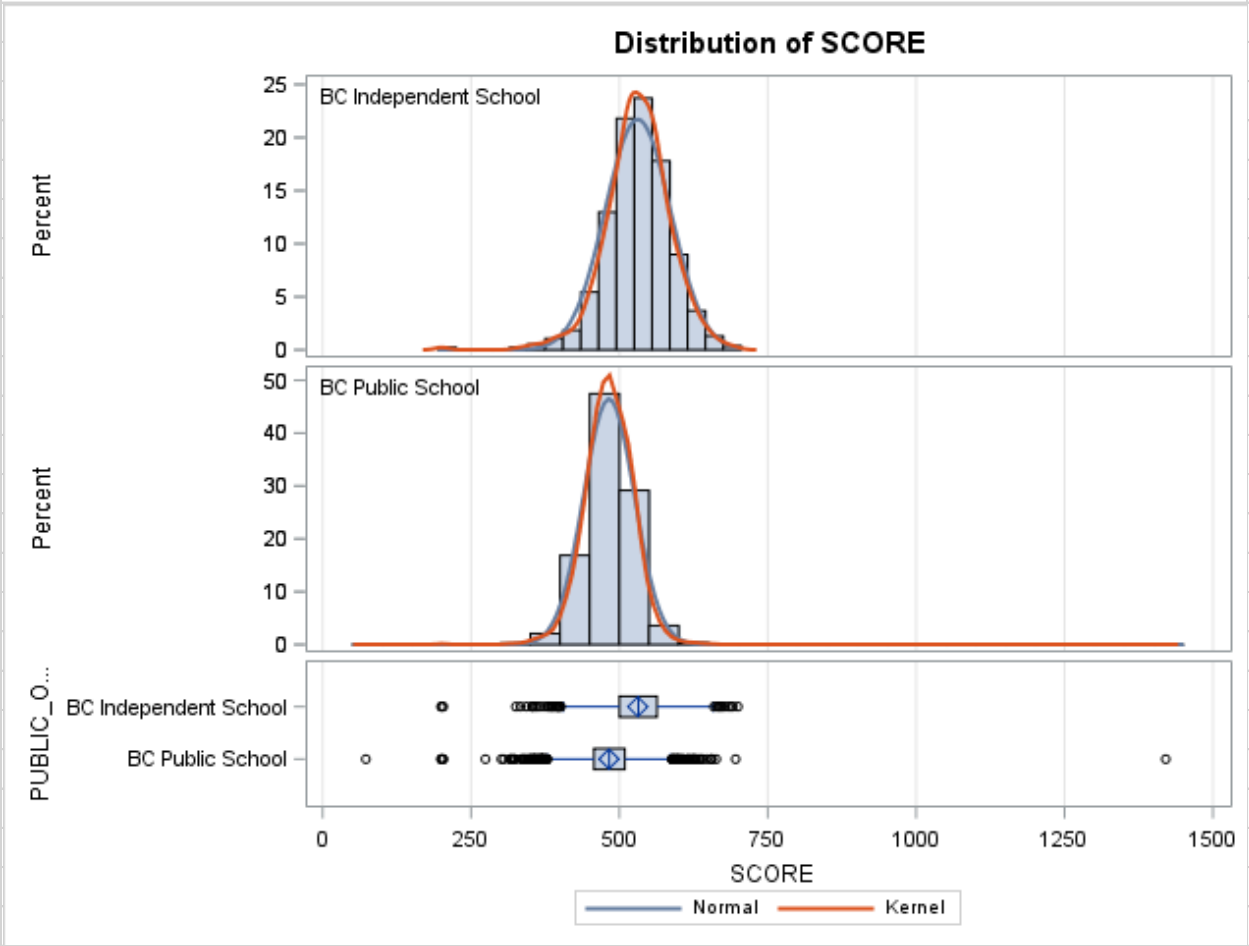

Exhibit D – Distribution of Reading Score and T-Table for 7th Graders

PUBLIC_OR_INDEPENDENT	N	Mean	Std Dev	Std Err	Minimum	Maximum
BC Independent School	1228	535.6	46.6781	1.332	200	659.8
BC Public School	5591	486.7	38.6282	0.5166	200	684.3
Diff (1-2)		48.8464	40.1962	1.2668		

PUBLIC_OR_INDEPENDENT	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
BC Independent School		535.6	533	538.2	46.6781	44.9023	48.6013
BC Public School		486.7	485.7	487.7	38.6282	37.9253	39.3578
Diff (1-2)	Pooled	48.8464	46.3631	51.3297	40.1962	39.5328	40.8825
Diff (1-2)	Satterthwaite	48.8464	46.0441	51.6487			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	6817	38.56	<.0001
Satterthwaite	Unequal	1615.9	34.19	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	1227	5590	1.46	<.0001

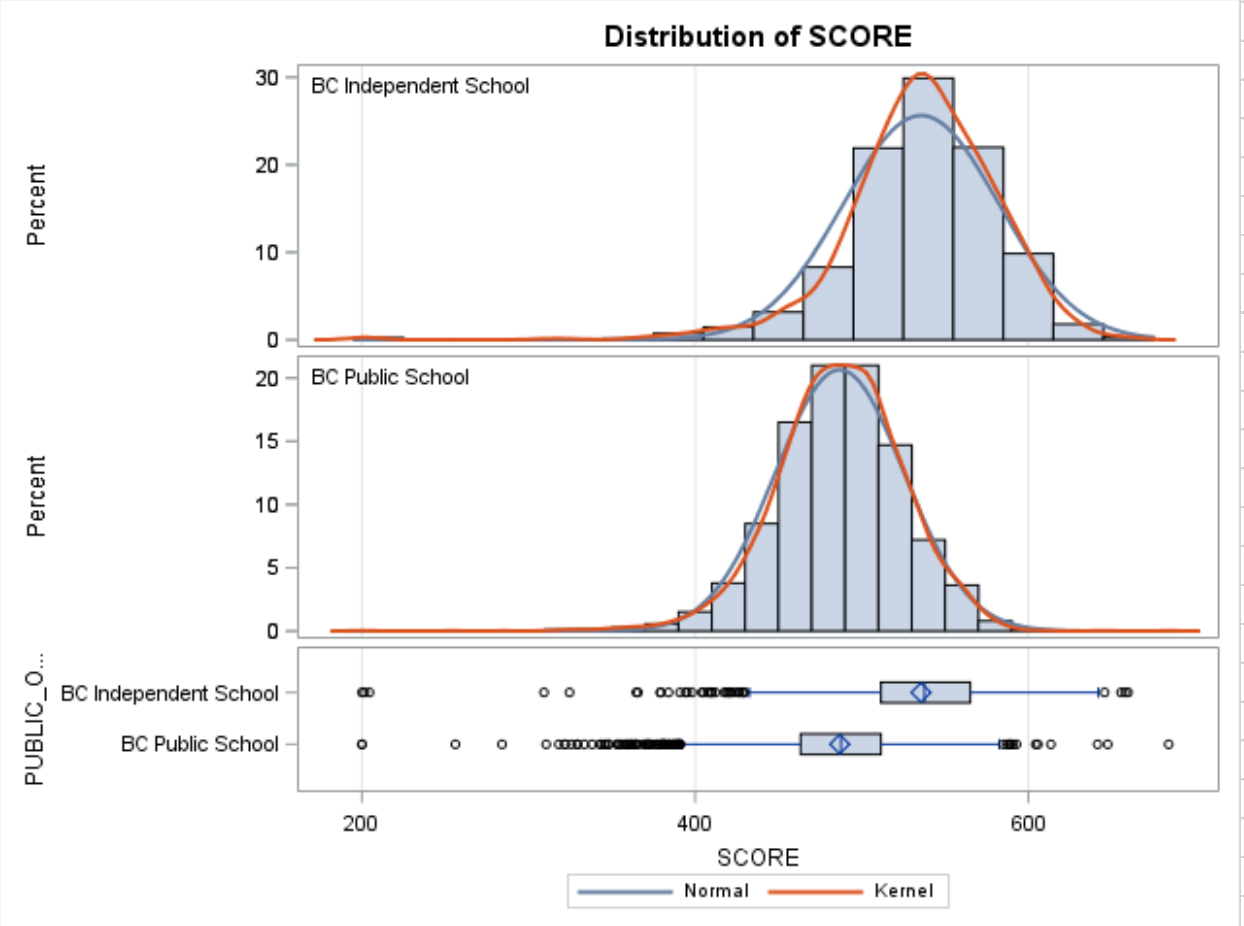

Exhibit E – Distribution of Writing Score and T-Table for 4th Graders

PUBLIC_OR_INDEPENDENT	N	Mean	Std Dev	Std Err	Minimum	Maximum
BC Independent School	1275	7.9011	1.1513	0.0322	1.8182	11.3273
BC Public School	7180	6.6743	0.9216	0.0109	2.8182	10.375
Diff (1-2)		1.2269	0.9598	0.0292		

PUBLIC_OR_INDEPENDENT	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
BC Independent School		7.9011	7.8379	7.9644	1.1513	1.1083	1.1978
BC Public School		6.6743	6.6529	6.6956	0.9216	0.9068	0.9369
Diff (1-2)	Pooled	1.2269	1.1697	1.284	0.9598	0.9455	0.9744
Diff (1-2)	Satterthwaite	1.2269	1.1601	1.2936			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	8453	42.06	<.0001
Satterthwaite	Unequal	1576.8	36.05	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	1274	7179	1.56	<.0001

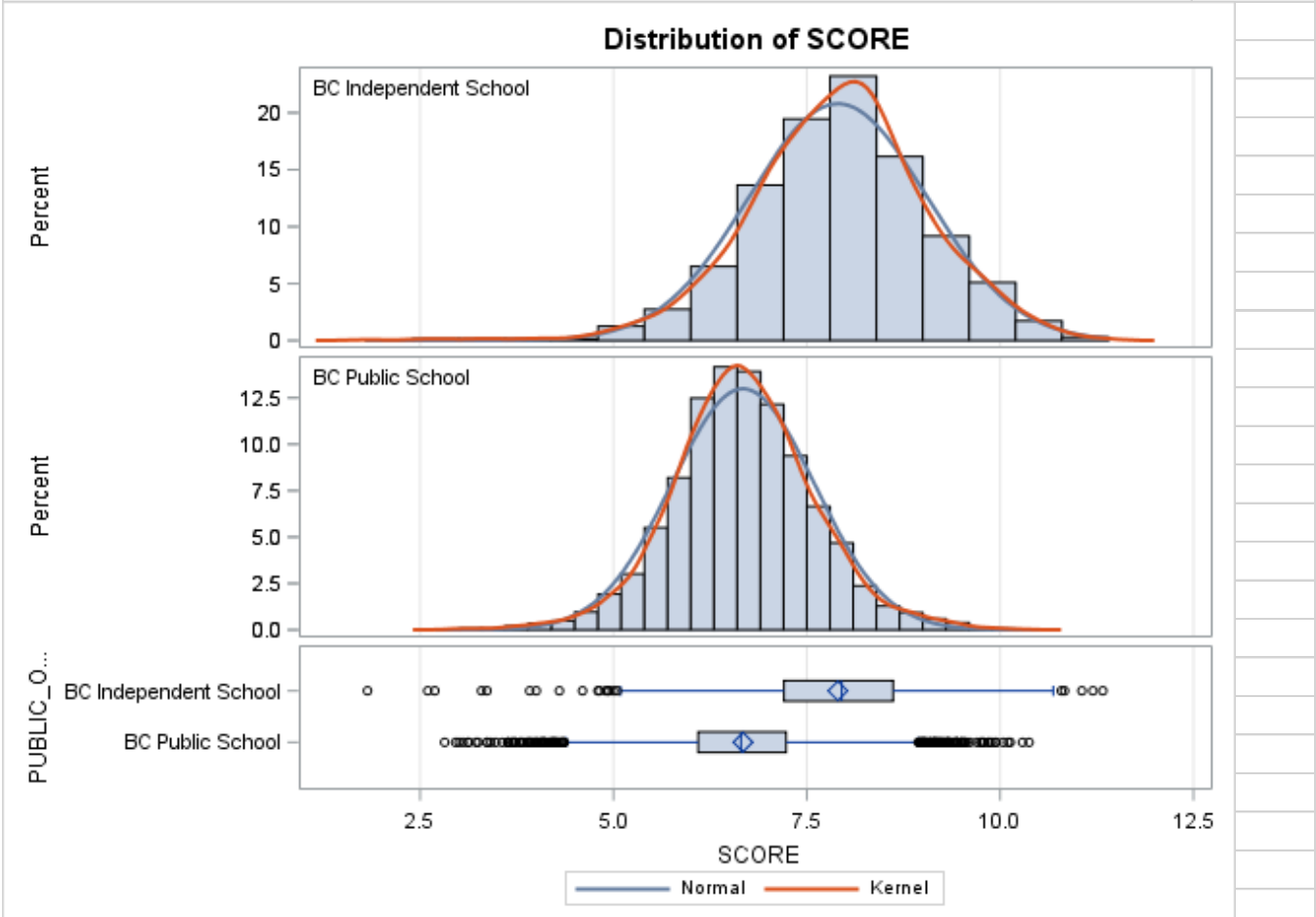

Exhibit F – Distribution of Writing Score and T-Table for 7th Graders

PUBLIC_OR_INDEPENDENT	N	Mean	Std Dev	Std Err	Minimum	Maximum
BC Independent School	1204	8.1557	1.1695	0.0337	3.5	11.8846
BC Public School	5549	6.7779	0.9476	0.0127	0.0909	10.6
Diff (1-2)		1.3778	0.9908	0.0315		

PUBLIC_OR_INDEPENDENT	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
BC Independent School		8.1557	8.0896	8.2218	1.1695	1.1246	1.2182
BC Public School		6.7779	6.753	6.8028	0.9476	0.9303	0.9655
Diff (1-2)	Pooled	1.3778	1.3161	1.4396	0.9908	0.9743	1.0078
Diff (1-2)	Satterthwaite	1.3778	1.3071	1.4485			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	6751	43.74	<.0001
Satterthwaite	Unequal	1563.2	38.24	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	1203	5548	1.52	<.0001