Homework 1

Data: 44 elementary school students were randomly assigned to one of two methods of teaching reading comprehension. Their reading comprehension was tested before and after 6 weeks in a class. Each student's comprehension change (post minus pre score) is given here and in the SAS code file:

Method: Basal

1, 1.5, -2.5, -2.5, -1, -5.5, -2.5, -4.5, 0, -1, -2, -1.5, -3.5, 1, -2, -0.5, -3.5, -3.5, -2.5, - 3.5, -0.5, 0

Method: DRTA

2, -1, 0, 0.5, -1.5, -1, 2, 1.5, -0.5, -1.5, 0, -0.5, 2, -0.5, 1, 4.5, 2, -1.5, 2.5, 0.5, 1.5, 1

Exercises:

1. Test whether the [average] reading comprehension change induced by the two methods is the same, using a two-sample t-test with a pooled variance estimate (i.e., assuming equal variances). Report the following:
   (a) Null and alternative hypotheses (you may refer to parameters μ_{Basal} and μ_{DRTA})
   (b) The "Distribution" plot of the two groups' values (including histograms and boxplots) from the SAS output
   (c) Value of (or useful range for) the p-value ("Pr $> |t|$" in SAS output)
   (d) Conclusion in context of these data (not just "reject" or "fail to reject", but what can you conclude about the two methods' effects on reading comprehension?) (It's okay to assume all relevant model assumptions are satisfied here.)

Answers:

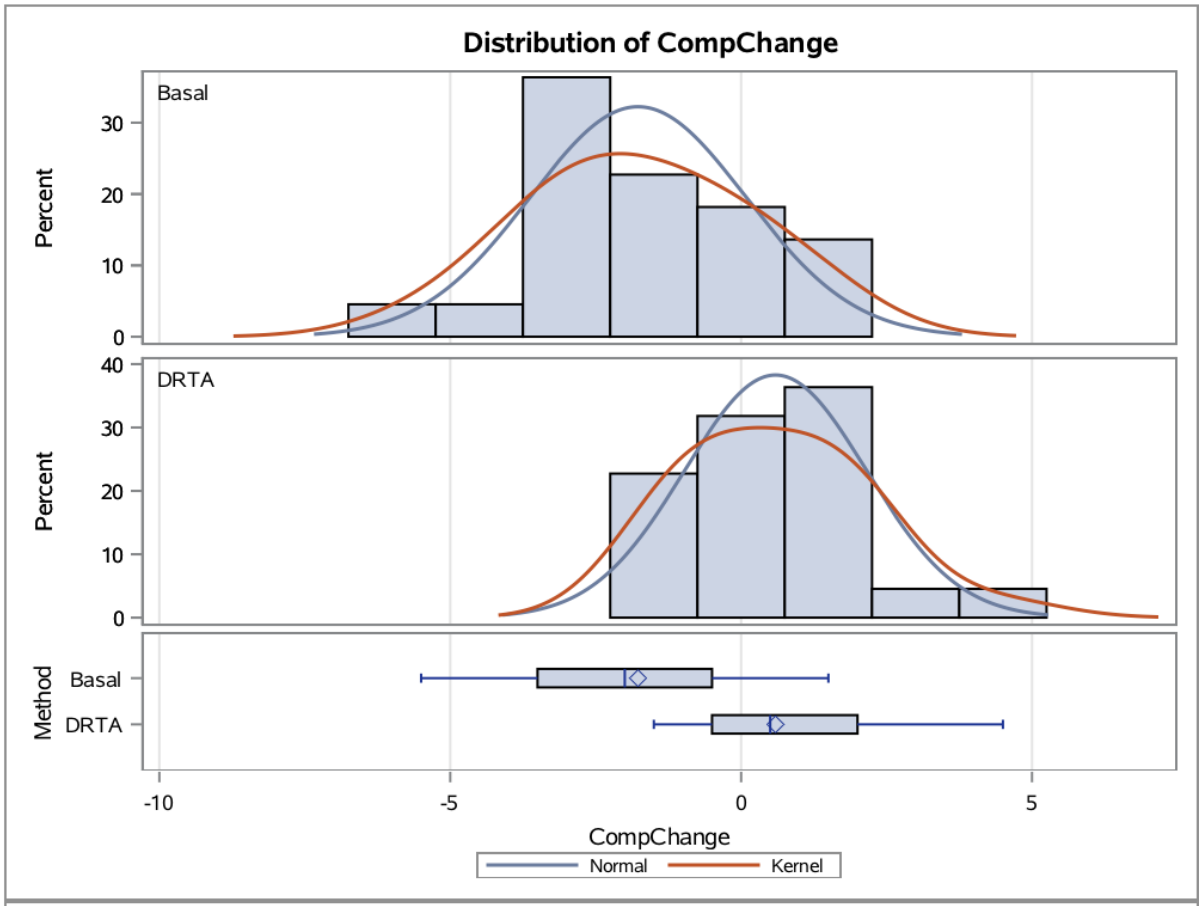
1. (a) In this instance, the null hypothesis (H_0) is defined by the mean of the Basal method's score change being equal to the mean of the DRTA method's score change ($\mu_{Basal} = \mu_{DRTA}$), whereas the alternative hypothesis (H_A) is defined by the mean of the Basal method's score change not being equal to the mean of the DRTA method's score change ($\mu_{Basal} \neq \mu_{DRTA}$).
   (b) The histograms of the data for both the Basal method's score change and the DRTA method's score change appear to be fairly symmetric, with their boxplots showing this estimation more clearly given the closeness of the respective means and medians. The Basal method's distribution ranges from -5.5 to 1.5 with a center that is between -2 and -1, and the DRTA method's distribution ranges from -1.5 to 4.5 (4.5 being a probable outlier) with a center that is between 0 and 1. The two distributions have similar spreads, but noticeably different centers. (See Page 3 for SAS Output.)
   (c) The given p-value for this set of data is < 0.0001, which indicates a strong likelihood that $\mu_{Basal} \neq \mu_{DRTA}$.

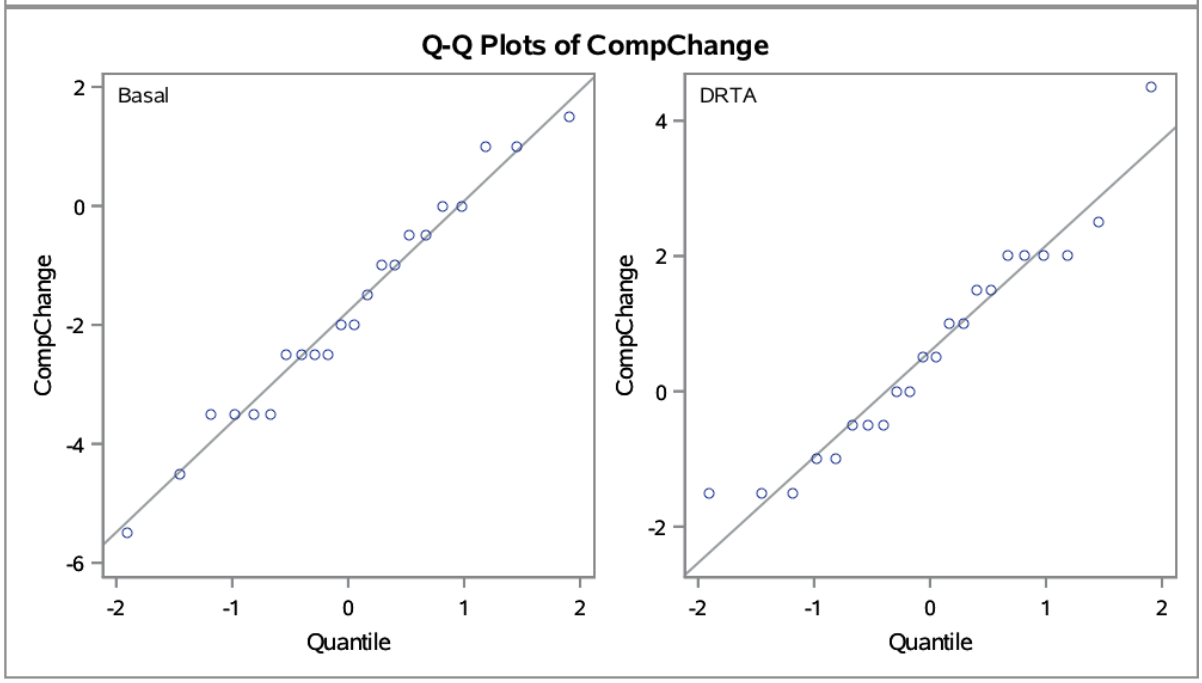
Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	42	-4.57	<.0001
Satterthwaite	Unequal	40.818	-4.57	<.0001

   (d) Given the immensely small p-value of < 0.0001, there is strong evidence that the difference between μ_{Basal} and μ_{DRTA} is statistically significant, and thus the decision is to reject H_0. The Basal method found a negative average score change, which suggests that reading comprehension scores were overall lower in the testing that was performed after 6 weeks of teaching. The DRTA method found a positive average score change, which suggests that reading comprehension scores were overall higher in the testing that was performed after 6 weeks of teaching. This implies that the Basal method was not a very effective tool in improving reading comprehension, but that the DRTA method was, even if only slightly. (See Page 2 for SAS Output).

Method	Method	N	Mean	Std Dev	Std Err	Minimum	Maximum
Basal		22	-1.7727	1.8563	0.3958	-5.5000	1.5000
DRTA		22	0.5909	1.5632	0.3333	-1.5000	4.5000
Diff (1-2)	Pooled		-2.3636	1.7160	0.5174		
Diff (1-2)	Satterthwaite		-2.3636		0.5174		

Method	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
Basal		-1.7727	-2.5958	-0.9497	1.8563	1.4282	2.6528
DRTA		0.5909	-0.1022	1.2840	1.5632	1.2027	2.2340
Diff (1-2)	Pooled	-2.3636	-3.4078	-1.3195	1.7160	1.4149	2.1811
Diff (1-2)	Satterthwaite	-2.3636	-3.4087	-1.3186			


Distribution of CompChange
Basal
DRTA
Percent
Method
Basal
DRTA
CompChange
Normal
Kernel


Q-Q Plots of CompChange
Basal
DRTA
CompChange
Quantile