

STAT 8801 Group Mu Project

Abhishek Nandy, Heidi Sutter, Yanjia Yu, Li Zhong, Megan Heyman, Yoo Jeong Jang

May 3, 2013

- 1 Part 1: Background
- 2 Part 2: Data Exploration
- 3 Part 3: Analysis

Background introduction:

Background introduction:

- Three teachers at a local high school conducted an experiment

Background introduction:

- Three teachers at a local high school conducted an experiment
- Want to study new styles of teaching delivery method

Background introduction:

- Three teachers at a local high school conducted an experiment
- Want to study new styles of teaching delivery method
- Tactile, Kinesthetic, Auditory, Visual

Objective of the experiment:

Objective of the experiment:

- Compare new style to traditional style

Objective of the experiment:

- Compare new style to traditional style
- New style help student learn better?

Objective of the experiment:

- Compare new style to traditional style
- New style help student learn better?
- Learning preference affect learning?

Objective of the experiment:

- Compare new style to traditional style
- New style help student learn better?
- Learning preference affect learning?
- How much does each new delivery method help?

Objective of the experiment:

- Compare new style to traditional style
- New style help student learn better?
- Learning preference affect learning?
- How much does each new delivery method help?
- Use different style for different course material?

Design of the experiment:

Design of the experiment:

- Three chosen topics were taught

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group
- New style of teaching for two classes

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group
- New style of teaching for two classes
- Traditional style for the control group

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group
- New style of teaching for two classes
- Traditional style for the control group
- Run order is randomized

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group
- New style of teaching for two classes
- Traditional style for the control group
- Run order is randomized
- Record test scores before and after teaching each topic

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group
- New style of teaching for two classes
- Traditional style for the control group
- Run order is randomized
- Record test scores before and after teaching each topic
- Record a higher learning score

Design of the experiment:

- Three chosen topics were taught
- For each topic, one class chosen as control group
- New style of teaching for two classes
- Traditional style for the control group
- Run order is randomized
- Record test scores before and after teaching each topic
- Record a higher learning score
- Record preference scores for new method

The dataset:

id	sex	class	p1	f1	s1	h1	p2	f2	s2	h2
s01	M	2	70	100	60	4	48	88	52	3
s02	F	2	80	85	60	2	50	76	60	3
p3	f3	s3	h3	t	k	a	v			
72	64	60	2	61	44	57	55			
70	72	60	1	35	44	57	34			

id: Student identifier

sex: Gender of Student

class: Class: 1,2,3 Control group: 3,1,2

p1, p2, p3: Pretest score (out of 100) for UNIT = 1,2,3

f1, f2, f3: Posttest score (out of 100) for UNIT = 1,2,3

s1, s2, s3: Attitude score (out of 60) for UNIT = 1,2,3

h1, h2, h3: Higher learning test score for UNIT = 1,2,3

t,k,a,v: Learning Style Preference (60+ is strong preference)

Response variable: difference of test scores, higher learning test score

Response variable: difference of test scores, higher learning test score

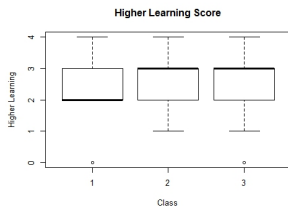
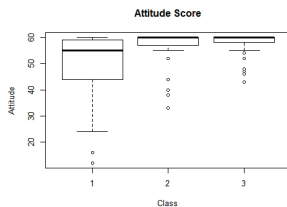
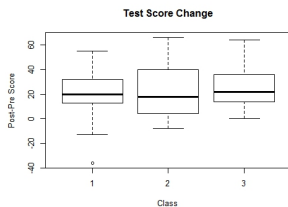
Possible predictors: Teaching(categorical variable), preference, attitude, gender

Part 2: Data Exploration



Possible Response Variables

Pre-Test, Post-Test, Attitude, Higher Learning: Recorded on each unit



Possible Response Variables (cont.)

Correlation in responses

	S	A	HL
S	1	0.05	0.42
A	-	1	0.10
HL	-	-	1

S=Score Change, A=Attitude, HL=Higher Learning

- Combined the test scores to measure change (post-pre)
 - Gives an idea how much students learn
 - Lose information about the high and low scores (100-70 is same as 70-40)
- Attitude: Mostly high scores with a few outliers. Higher variability in class 1.
- **Further analysis conducted by our group only used change in score.**

Possible Response Variables (cont.)

Of those having an attitude score of 40 or less

- **14** are in class 1 and the other **3** are in class 2
- **13** are female
- **2** in Unit 1, **9** in Unit 2, **6** in Unit 3
- **2** students gave low attitude scores on all three units
 - One of these had failing scores on all 3 post tests
 - The other failed only one post test but had A's on the others.

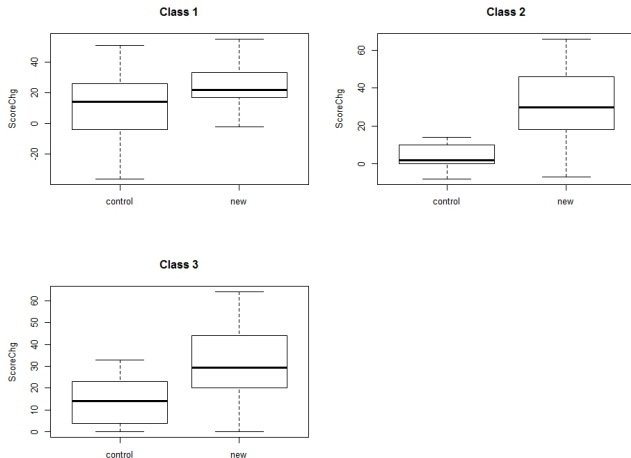
Some Interesting Statistics

Strong Learning Style Preference (60+ on 1-100 scale)

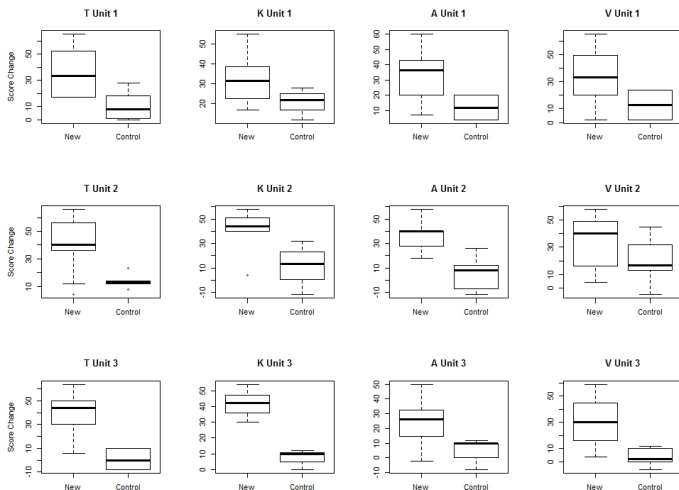
	T	K	A	V
	6	2	4	7
T	-	2	4	4
K	-	-	1	0
A	-	-	-	0
TK	-	-	1	4
AV	1	1	-	-
KAV	0	-	-	-

22 students did not have any strong preference.

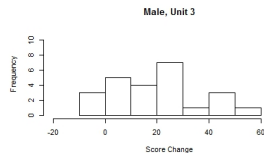
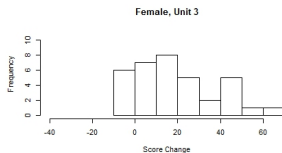
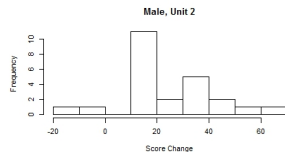
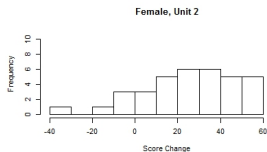
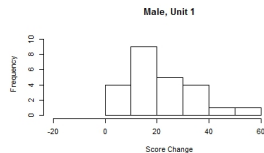
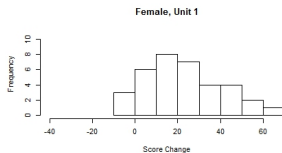
Method vs. Change in Test overall



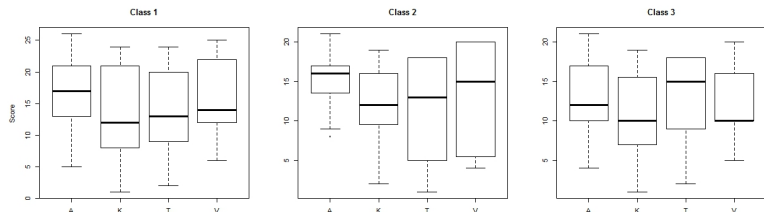
High T, K, A, V vs. Change in Test



Unit and Gender with Score Change



Summaries Covariate by Class



	Male	Female
Class 1	9	12
Class 2	14	7
Class 3	11	10

Part 3: Analysis (Section 1)



Linear Model for Part 1

- $m1 < -lm(y \sim sex * method * (t + k + a + v) + class + unit)$
- y : score change; sex: 1-Male, 0-Female; method: 1-New, 0-Traditional; t , k , a , v : 0-100; class, unit: block
- reasons:
- $unit$ as a block (e.g.: gravitation, electrostatics, magnetism)
- $class$ as a block (three teacher each teaches the same class through all three units)
- there is no significant interactions between t , k , a , v

Results for m1: ANOVA Table

```

> car::Anova(m1)
Anova Table (Type II tests)
Response: y

```

	Sum Sq	Df	F value	Pr(>F)
sex	69	1	0.3029	0.582877
method	14180	1	62.3825	5.124e-13 ***
t	1321	1	5.8108	0.017115 *
k	13	1	0.0580	0.809991
a	52	1	0.2270	0.634449
v	267	1	1.1757	0.279929
class	778	2	1.7120	0.183939
unit	490	2	1.0771	0.343145
sex:method	108	1	0.4753	0.491602
sex:t	5	1	0.0205	0.886250
sex:k	99	1	0.4352	0.510430
sex:a	31	1	0.1362	0.712620
sex:v	466	1	2.0501	0.154237
method:t	2430	1	10.6898	0.001331 **
method:k	12	1	0.0542	0.816200
method:a	502	1	2.2066	0.139479
method:v	33	1	0.1462	0.702749
sex:method:t	27	1	0.1172	0.732512
sex:method:k	106	1	0.4664	0.495681
sex:method:a	9	1	0.0392	0.843298
sex:method:v	18	1	0.0796	0.778173
Residuals	34779	153		

Variable Selection

```

> library(MASS)
> stepAIC(lm(y~sex*method*(t+k+a+v)+class+unit),
+         scope = list(upper= y~sex*method*(t+k+a+v)+class+unit,
+                       lower= y~1+class+unit),direction="backward")
...
Call:
lm(formula = y ~ sex + method + t + a + v + class + unit + sex:v +
    method:t + method:a)
Coefficients:
(Intercept)      sex1      method1          t1          a
  11.3810      16.3395     -10.5335     -6.2979     -0.2237
          v      class2      class3      unit2      unit3
   0.2725     -2.3364      3.0217      1.9050     -2.2453
    sex1:v  method1:t1  method1:a
  -0.3464    20.7686      0.4128

```

So, we get the updated model m2:

$$y \sim \text{sex} + \text{method} + t + a + v + \text{class} + \text{unit} + \text{sex} : v + \text{method} : t + \text{method} : a$$

Results for m2: ANOVA Table

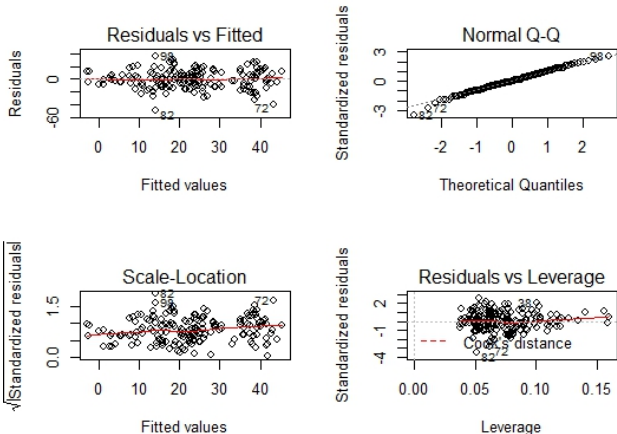
```
> car::Anova(m2)
Anova Table (Type II tests)
Response: y
```

	Sum Sq	Df	F value	Pr(>F)	
sex	69	1	0.3215	0.571468	
method	14180	1	66.0148	1.028e-13	***
t	2105	1	9.8010	0.002065	**
a	30	1	0.1382	0.710560	
v	280	1	1.3029	0.255349	
class	709	2	1.6513	0.194981	
unit	495	2	1.1521	0.318525	
sex:v	624	1	2.9036	0.090275	.
method:t	3843	1	17.8920	3.878e-05	***
method:a	583	1	2.7118	0.101520	
Residuals	35228	164			

Results for m2: Summary

```
> summary(m2)
Call:
lm(formula = y ~ sex + method + t + a + v + class + unit + sex:v +
    method:t + method:a)
...
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  11.3810    15.2375   0.747  0.4562
sex1         16.3395    10.6097   1.540  0.1255
method1     -10.5335    13.6946  -0.769  0.4429
t1          -6.2979     4.0654  -1.549  0.1233
a           -0.2237     0.2170  -1.031  0.3041
v            0.2725     0.1414   1.927  0.0557 .
class2      -2.3364     2.7666  -0.845  0.3996
class3       3.0217     2.8180   1.072  0.2852
unit2        1.9050     2.7282   0.698  0.4860
unit3       -2.2453     2.7383  -0.820  0.4134
sex1:v       -0.3464     0.2033  -1.704  0.0903 .
method1:t1   20.7686     4.9100   4.230 3.88e-05 ***
method1:a     0.4128     0.2507   1.647  0.1015
```


Model Diagnostic



Conclusion about the Influence of New Method

- On average, the new method improves students' performance of score change.
- For students with a high value on t or a , they benefit more than other students.

Some More Analysis Using SPSS

		Coefficients ^a						
		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	14.526	3.518		4.129	.000	7.482	21.571
	taught by new teaching method for unit 1	13.074	4.272	.376	3.060	.003	4.518	21.629
2	(Constant)	16.472	4.742		3.473	.001	6.941	26.002
	taught by new teaching method for unit 1	3.751	5.891	.108	.637	.527	-8.087	15.589
	preference for learning style t	-11.220	8.048	-.334	-1.394	.170	-27.393	4.954
	preference for learning style k	11.675	10.171	.280	1.148	.257	-8.765	32.115
	preference for learning style a	1.138	11.539	.028	.099	.922	-22.050	24.326
	preference for learning style v	7.748	12.866	.207	.602	.550	-18.107	33.603
	interaction between t.type an intervention 1	21.868	9.604	.572	2.277	.027	2.568	41.168
	interaction between k.type an intervention 1	-13.376	12.072	-.282	-1.108	.273	-37.636	10.883
	interaction between a.type an intervention 1	5.726	12.870	.132	.445	.658	-20.138	31.590
interaction between v.type an intervention 1	-.748	13.977	-.019	-.054	.958	-28.836	27.340	

a. Dependent Variable: change score for unit 1

Some More Analysis Using SPSS, cont.

Model		Coefficients ^a						
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	13.667	4.018		3.401	.001	5.620	21.713
	taught by new teaching method for unit 2	18.412	5.007	.438	3.677	.001	8.386	28.439
2	(Constant)	16.834	5.576		3.019	.004	5.629	28.039
	taught by new teaching method for unit 2	7.823	7.049	.186	1.110	.273	-6.343	21.989
	preference for learning style t	4.503	10.201	.108	.441	.661	-15.998	25.003
	preference for learning style k	-2.679	10.880	-.052	-.246	.807	-24.543	19.186
	preference for learning style a	-12.699	10.227	-.254	-1.242	.220	-33.251	7.852
	preference for learning style v	-2.964	10.552	-.064	-.281	.780	-24.170	18.242
	interaction between t.type an intervention 2	10.883	11.931	.245	.912	.366	-13.093	34.859
	interaction between k.type an intervention 2	9.309	13.466	.150	.691	.493	-17.751	36.369
	interaction between a.type an intervention 2	14.268	12.772	.229	1.117	.269	-11.399	39.935
	interaction between v.type an intervention 2	-.727	12.574	-.014	-.058	.954	-25.995	24.540

a. Dependent Variable: change score for unit 2

Some More Analysis Using SPSS, cont.

Model		Coefficients ^a						
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Bound	Bound
1	(Constant)	2.737	3.085		.887	.379	-3.440	8.914
	taught by new teaching method for unit 3	25.538	3.746	.670	6.817	.000	18.036	33.040
2	(Constant)	3.356	4.210		.797	.429	-5.105	11.817
	taught by new teaching method for unit 3	20.132	4.835	.528	4.163	.000	10.415	29.849
	preference for learning style t	-6.967	5.261	-.189	-1.324	.192	-17.539	3.605
	preference for learning style k	8.052	7.114	.176	1.132	.263	-6.244	22.349
	preference for learning style a	1.956	5.994	.044	.326	.746	-10.090	14.001
	preference for learning style v	1.119	5.463	.027	.205	.839	-9.858	12.097
	interaction between t.type an intervention 3	24.644	6.579	.574	3.746	.000	11.422	37.866
	interaction between k.type an intervention 3	3.762	8.530	.068	.441	.661	-13.380	20.904
	interaction between a.type an intervention 3	-10.707	7.629	-.194	-1.403	.167	-26.038	4.624
interaction between v.type an intervention 3	-9.655	7.301	-.175	-1.322	.192	-24.327	5.017	

a. Dependent Variable: change score for unit 3

Conclusion about the Influence of New Method

- On average, the new method improves students' performance of score change.
- For students with a high value on t , they benefit more than other students.

Part 3: Analysis (Section 2)



Question 2

Does the new teaching method especially help any of the learning types?

Variables of interest:

Learning Types - Binary Variable (1 if 60+, 0 if less than 60):

Tactile

Kinesthetic

Auditory

Visual

Teaching Method - Binary (1 if New, 0 if Control)

Score Difference between Pre- and Post-Tests for each Unit

Question 2: Type of Analysis

Linear Models

For each unit:

Score diff \sim T + K + A + V + Method + two-way interactions

Two-Sample T-Tests

For each unit and learning type, compare the average score difference for the new and control methods:

$$H_0 : \mu_{new} = \mu_{control}$$

$$H_1 : \mu_{new} > \mu_{control}$$

Question 2: Two-Sample T-Test Assumptions

Independent Samples

- Students independently took pre- and post-tests
- Possible within-class correlation

Normality Assumption (Shapiro-Wilks Test)

- 20 of the samples met the normality assumption
- 2 samples failed to meet the assumption
- 2 samples had fewer than 3 data points

Variance

Samples had unequal variances, which we accounted for when running the t-tests

Question 2: Two-Sample T-Test

Bonferroni Adjusted P-Values

	T	K	A	V
Unit 1	0.0028	0.7444	0.9480	1.0000
Unit 2	0.0001	0.2326	0.0423	0.9994
Unit 3	0.0000	0.0002	0.1716	0.0259

Conclusions: The new teaching method is helpful for..

- Strong tactile learners, for all three units.
- Strong auditory learners for Unit 2.
- Strong kinesthetic and visual learners for Unit 3.