BGSU College of Education and Human Development
BOWLING GREEN STATE UNIVERSITY

Using Aggregate Unit Pre/Post Assessment Results Across Classrooms

A Monte Carlo Study Proof of Concept in Program Evaluation

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Materials and Agenda

1. The Data Set
   a. The Teacher Work Sample & the TWS GraphMaker
   b. Issues w/ Teacher-Made & Teacher-Selected Tests
2. Monte Carlo Simulation
   a. Purpose and Design of Simulation
   b. Simulated Conditions & Replications
   c. Findings & Recommendations
3. Methodological Application
   a. Evaluation Situation: Multi-Tiered ESOL Preparation
   b. Evaluation Questions & Methods
   c. Findings & Discussion
4. Questions

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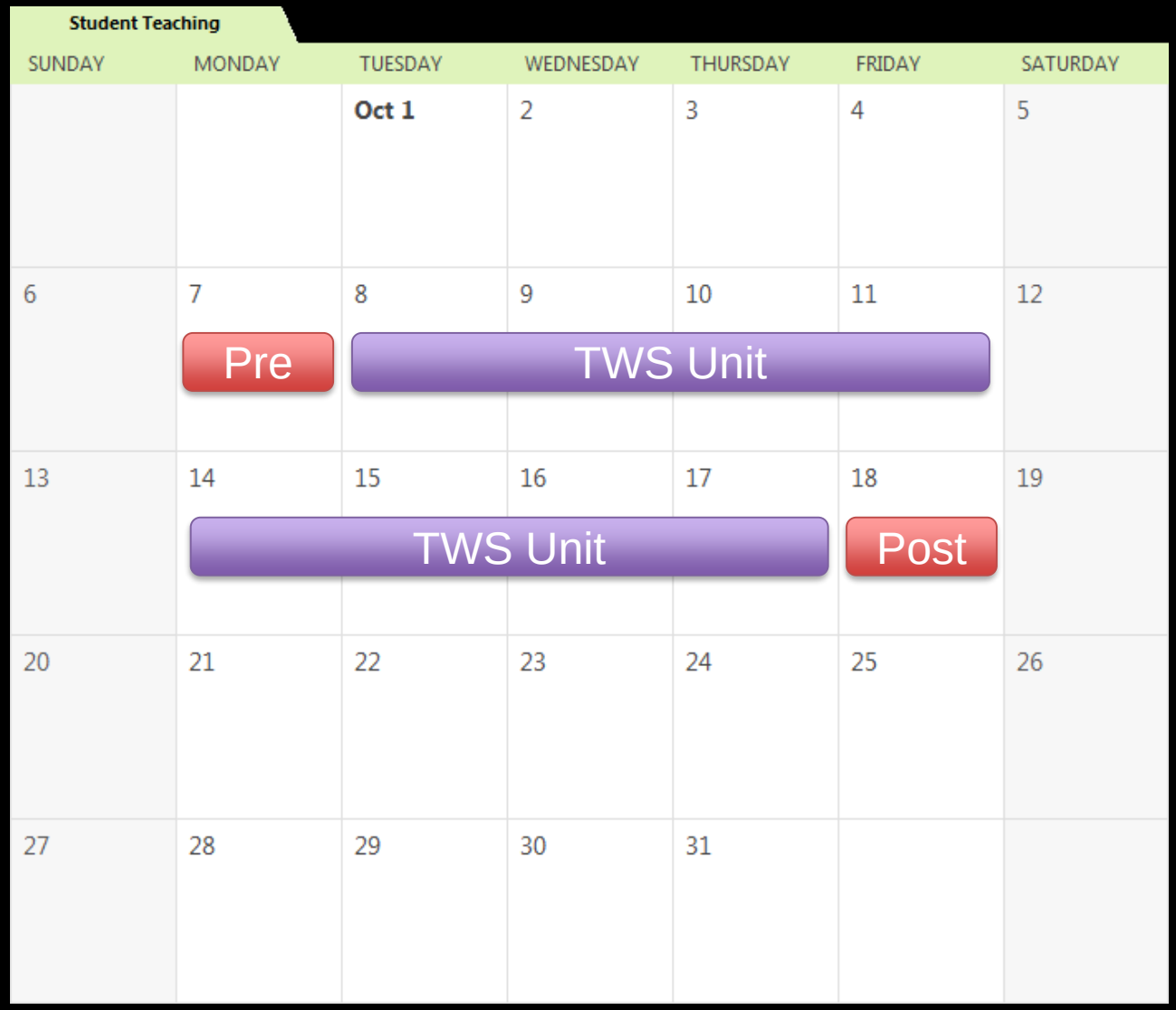
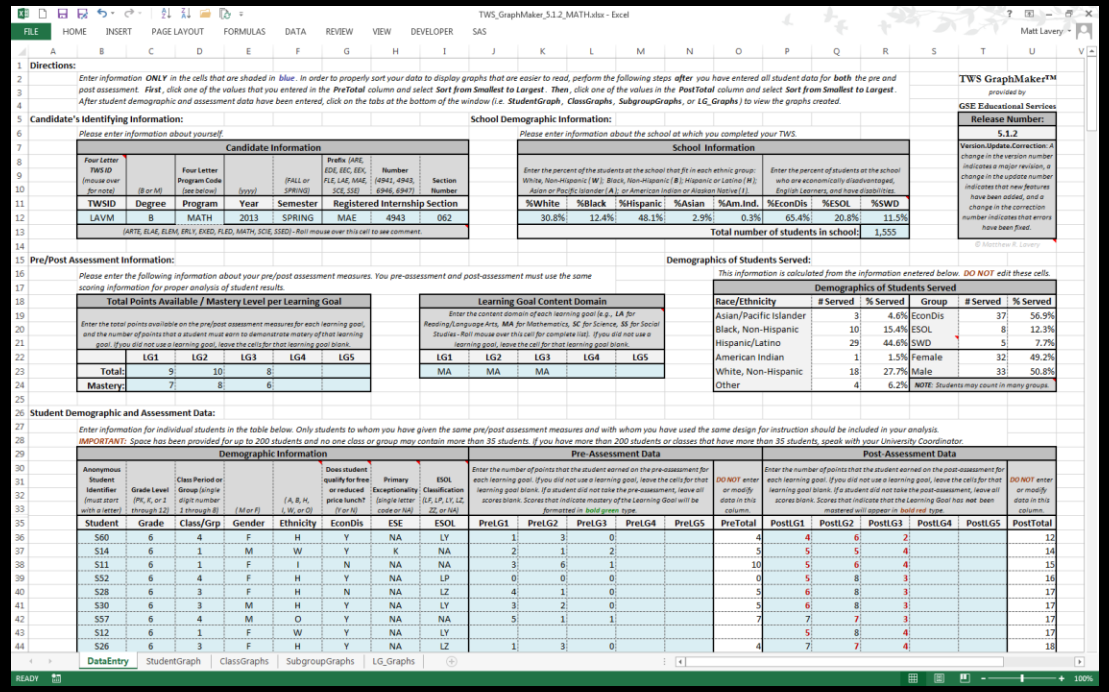
The Data Set

Teacher Work Sample (TWS)





TWS_GraphMaker_5.1.2_MATH.xlsx - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW DEVELOPER SAS

Matt Lavery

Directions:

Enter information ***ONLY*** *in the cells that are shaded in* ***blue****. In order to properly sort your data to display graphs that are easier to read, perform the following steps* ***after*** *you have entered all student data for* ***both*** *the pre and post assessment. First, click one of the values that you entered in the* ***PreTotal*** *column and select* ***Sort from Smallest to Largest****. Then, click one of the values in the* ***PostTotal*** *column and select* ***Sort from Smallest to Largest****. After student demographic and assessment data have been entered, click on the tabs at the bottom of the window (i.e.* ***StudentGraph****,* ***ClassGraphs****,* ***SubgroupGraphs****, or* ***LG_Graphs****) to view the graphs created.*

TWS GraphMaker™
provided by
GSE Educational Services

Release Number:
5.1.2

Version.Update.Correction: A change in the version number indicates a major revision, a change in the update number indicates that new features have been added, and a change in the correction number indicates that errors have been fixed.

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Candidate's Identifying Information:

Please enter information about yourself.

Candidate Information							
Four Letter TWSID (mouse over for note)	(B or M)	Four Letter Program Code (see below)	(yyyy)	(FALL or SPRING)	Prefix (ARE, EDE, EEC, EEK, FLE, LAE, MAE, SCE, SSE)	Number (4941, 4943, 6946, 6947)	Section Number
TWSID	Degree	Program	Year	Semester	Registered Internship Section		
LAVM	B	MATH	2013	SPRING	MAE	4943	062

[ARTE, ELAE, ELEM, ERLY, EXED, FLED, MATH, SCIE, SSED] - Roll mouse over this cell to see comment.

School Demographic Information:

Please enter information about the school at which you completed your TWS.

School Information							
Enter the percent of the students at the school that fit in each ethnic group: White, Non-Hispanic (W); Black, Non-Hispanic (B); Hispanic or Latino (H); Asian or Pacific Islander (A); or American Indian or Alaskan Native (I).					Enter the percent of students at the school who are economically disadvantaged, English Learners, and have disabilities.		
%White	%Black	%Hispanic	%Asian	%Am.Ind.	%EconDis	%ESOL	%SWD
30.8%	12.4%	48.1%	2.9%	0.3%	65.4%	20.8%	11.5%
Total number of students in school:					1,555		

Pre/Post Assessment Information:

Please enter the following information about your pre/post assessment measures. You pre-assessment and post-assessment must use the same scoring information for proper analysis of student results.

Total Points Available / Mastery Level per Learning Goal					
Enter the total points available on the pre/post assessment measures for each learning goal, and the number of points that a student must earn to demonstrate mastery of that learning goal. If you did not use a learning goal, leave the cells for that learning goal blank.					
	LG1	LG2	LG3	LG4	LG5
Total:	9	10	8		
Mastery:	7	8	6		

Learning Goal Content Domain				
Enter the content domain of each learning goal (e.g., LA for Reading/Language Arts, MA for Mathematics, SC for Science, SS for Social Studies - Roll mouse over this cell for complete list). If you did not use a learning goal, leave the cell for that learning goal blank.				
LG1	LG2	LG3	LG4	LG5
MA	MA	MA		

Demographics of Students Served:

This information is calculated from the information enetered below. DO NOT edit these cells.

Demographics of Students Served					
Race/Ethnicity	# Served	% Served	Group	# Served	% Served
Asian/Pacific Islander	3	4.6%	EconDis	37	56.9%
Black, Non-Hispanic	10	15.4%	ESOL	8	12.3%
Hispanic/Latino	29	44.6%	SWD	5	7.7%
American Indian	1	1.5%	Female	32	49.2%
White, Non-Hispanic	18	27.7%	Male	33	50.8%
Other	4	6.2%	*NOTE: Students may count in many groups.*		

Student Demographic and Assessment Data:

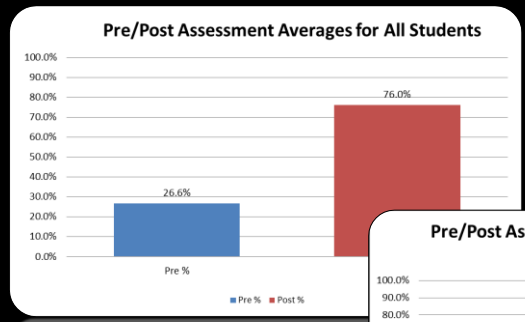
Enter information for individual students in the table below. Only students to whom you have given the same pre/post assessment measures and with whom you have used the same design for instruction should be included in your analysis.

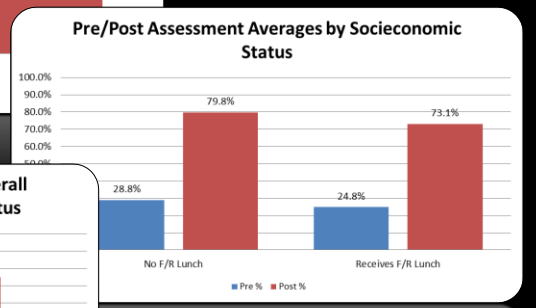
IMPORTANT: *Space has been provided for up to 200 students and no one class or group may contain more than 35 students. If you have more than 200 students or classes that have more than 35 students, speak with your University Coordinator.*

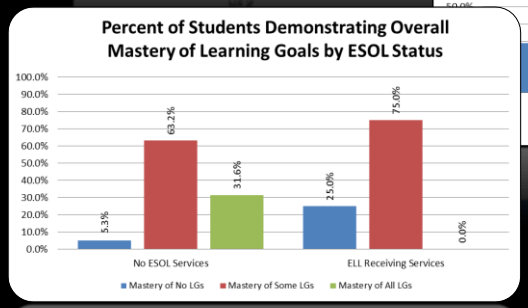
Demographic Information								Pre-Assessment Data						Post-Assessment Data					
Anonymous Student Identifier (must start with a letter)	Grade Level (PK, K, or 1 through 12)	Class Period or Group (single digit number 1 through 8)	(M or F)	(A, B, H, I, W, or O)	Does student qualify for free or reduced price lunch? (Y or N)	Primary Exceptionality (single letter code or NA)	ESOL Classification (LF, LP, LY, LZ, ZZ, or NA)	Enter the number of points that the student earned on the pre-assessment for each learning goal. If you did not use a learning goal, leave the cells for that learning goal blank. If a student did not take the pre-assessment, leave all scores blank. Scores that indicate mastery of the Learning Goal will be formatted in bold green type.					DO NOT enter or modify data in this column.	Enter the number of points that the student earned on the post-assessment for each learning goal. If you did not use a learning goal, leave the cells for that learning goal blank. If a student did not take the post-assessment, leave all scores blank. Scores that indicate that the Learning Goal has not been mastered will appear in bold red type.					DO NOT enter or modify data in this column.
Student	Grade	Class/Grp	Gender	Ethnicity	EconDis	ESE	ESOL	PreLG1	PreLG2	PreLG3	PreLG4	PreLG5	PreTotal	PostLG1	PostLG2	PostLG3	PostLG4	PostLG5	PostTotal
S60	6	4	F	H	Y	NA	LY	1	3	0			4	4	6	2			12
S14	6	1	M	W	Y	K	NA	2	1	2			5	5	5	4			14
S11	6	1	F	I	N	NA	NA	3	6	1			10	5	6	4			15
S52	6	4	F	H	Y	NA	LP	0	0	0			0	5	8	3			16
S28	6	3	F	H	N	NA	LZ	4	1	0			5	6	8	3			17
S30	6	3	M	H	Y	NA	LY	3	2	0			5	6	8	3			17
S57	6	4	M	O	Y	NA	NA	5	1	1			7	7	7	3			17
S12	6	1	F	W	Y	NA	LY							5	8	4			17
S26	6	3	F	H	Y	NA	LZ	1	3	0			4	7	7	4			18

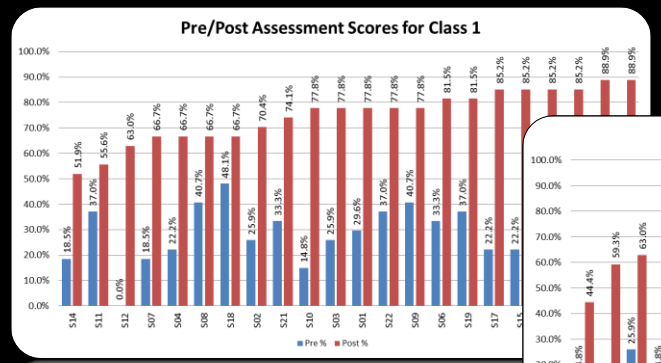
DataEntry | StudentGraph | ClassGraphs | SubgroupGraphs | LG_Graphs

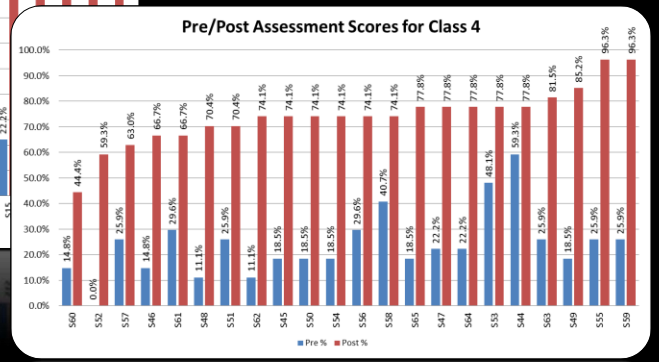
READY 100%



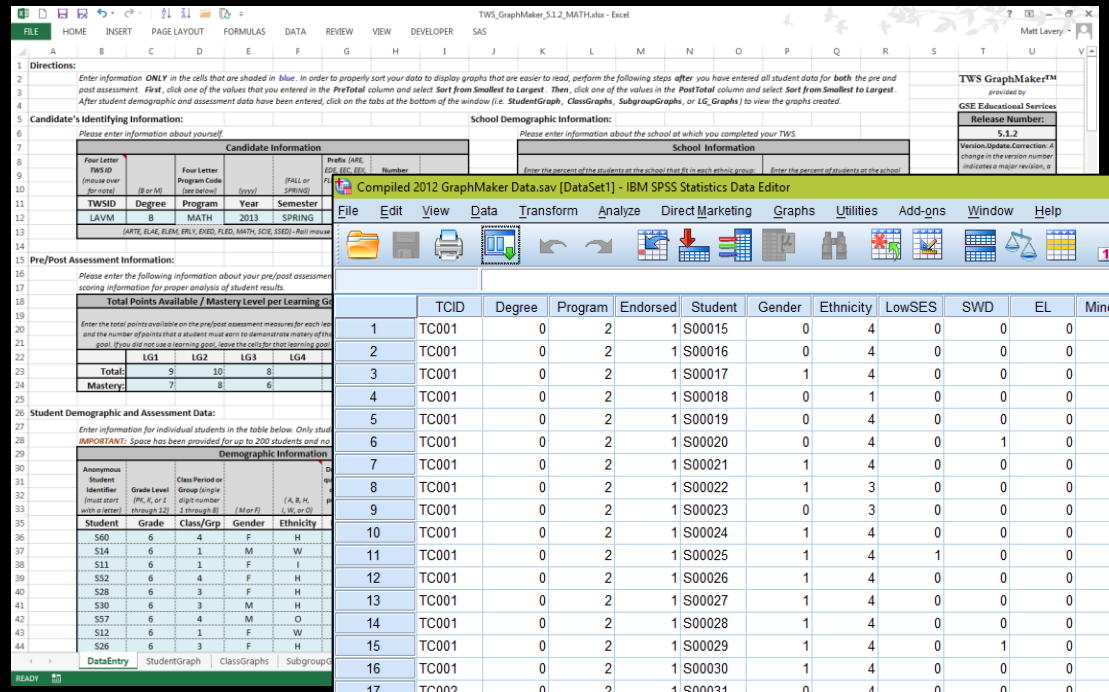


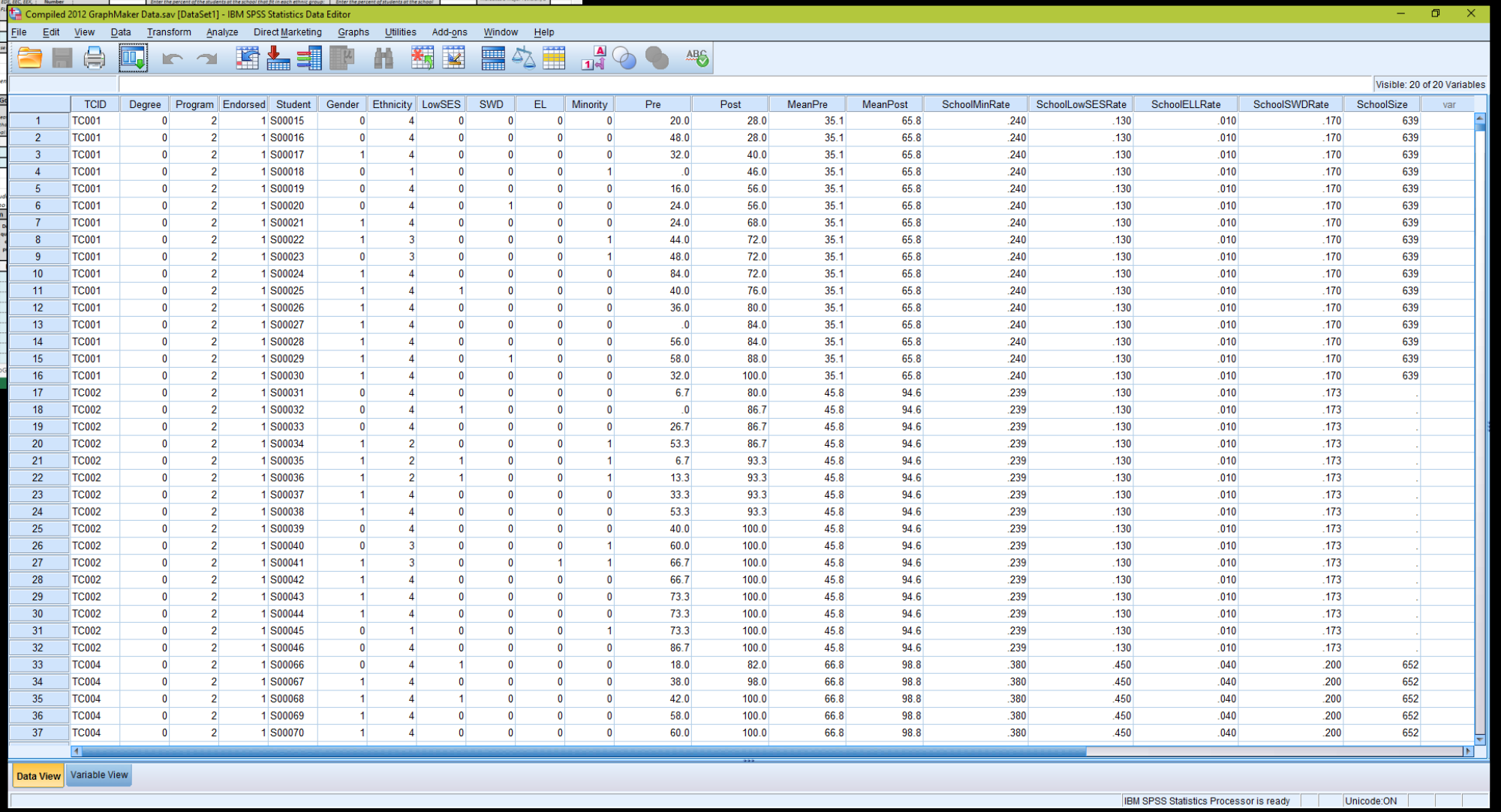






All TWS training materials and resources (including the TWS GraphMaker) are available at http://education.ucf.edu/clinicalexp/TWS.cfm





	TCID	Degree	Program	Endorsed	Student	Gender	Ethnicity	LowSES	SWD	EL	Minority	Pre	Post	MeanPre	MeanPost	SchoolMinRate	SchoolLowSESRate	SchoolELLRate	SchoolSWDRate	SchoolSize	var
1	TC001	0	2	1	S00015	0	4	0	0	0	0	20.0	28.0	35.1	65.8	.240	.130	.010	.170	639	
2	TC001	0	2	1	S00016	0	4	0	0	0	0	48.0	28.0	35.1	65.8	.240	.130	.010	.170	639	
3	TC001	0	2	1	S00017	1	4	0	0	0	0	32.0	40.0	35.1	65.8	.240	.130	.010	.170	639	
4	TC001	0	2	1	S00018	0	1	0	0	0	1	.0	46.0	35.1	65.8	.240	.130	.010	.170	639	
5	TC001	0	2	1	S00019	0	4	0	0	0	0	16.0	56.0	35.1	65.8	.240	.130	.010	.170	639	
6	TC001	0	2	1	S00020	0	4	0	1	0	0	24.0	56.0	35.1	65.8	.240	.130	.010	.170	639	
7	TC001	0	2	1	S00021	1	4	0	0	0	0	24.0	68.0	35.1	65.8	.240	.130	.010	.170	639	
8	TC001	0	2	1	S00022	1	3	0	0	0	1	44.0	72.0	35.1	65.8	.240	.130	.010	.170	639	
9	TC001	0	2	1	S00023	0	3	0	0	0	1	48.0	72.0	35.1	65.8	.240	.130	.010	.170	639	
10	TC001	0	2	1	S00024	1	4	0	0	0	0	84.0	72.0	35.1	65.8	.240	.130	.010	.170	639	
11	TC001	0	2	1	S00025	1	4	1	0	0	0	40.0	76.0	35.1	65.8	.240	.130	.010	.170	639	
12	TC001	0	2	1	S00026	1	4	0	0	0	0	36.0	80.0	35.1	65.8	.240	.130	.010	.170	639	
13	TC001	0	2	1	S00027	1	4	0	0	0	0	.0	84.0	35.1	65.8	.240	.130	.010	.170	639	
14	TC001	0	2	1	S00028	1	4	0	0	0	0	56.0	84.0	35.1	65.8	.240	.130	.010	.170	639	
15	TC001	0	2	1	S00029	1	4	0	1	0	0	58.0	88.0	35.1	65.8	.240	.130	.010	.170	639	
16	TC001	0	2	1	S00030	1	4	0	0	0	0	32.0	100.0	35.1	65.8	.240	.130	.010	.170	639	
17	TC002	0	2	1	S00031	0	4	0	0	0	0	6.7	80.0	45.8	94.6	.239	.130	.010	.173	.	
18	TC002	0	2	1	S00032	0	4	1	0	0	0	.0	86.7	45.8	94.6	.239	.130	.010	.173	.	
19	TC002	0	2	1	S00033	0	4	0	0	0	0	26.7	86.7	45.8	94.6	.239	.130	.010	.173	.	
20	TC002	0	2	1	S00034	1	2	0	0	0	1	53.3	86.7	45.8	94.6	.239	.130	.010	.173	.	
21	TC002	0	2	1	S00035	1	2	1	0	0	1	6.7	93.3	45.8	94.6	.239	.130	.010	.173	.	
22	TC002	0	2	1	S00036	1	2	1	0	0	1	13.3	93.3	45.8	94.6	.239	.130	.010	.173	.	
23	TC002	0	2	1	S00037	1	4	0	0	0	0	33.3	93.3	45.8	94.6	.239	.130	.010	.173	.	
24	TC002	0	2	1	S00038	1	4	0	0	0	0	53.3	93.3	45.8	94.6	.239	.130	.010	.173	.	
25	TC002	0	2	1	S00039	0	4	0	0	0	0	40.0	100.0	45.8	94.6	.239	.130	.010	.173	.	
26	TC002	0	2	1	S00040	0	3	0	0	0	1	60.0	100.0	45.8	94.6	.239	.130	.010	.173	.	
27	TC002	0	2	1	S00041	1	3	0	0	1	1	66.7	100.0	45.8	94.6	.239	.130	.010	.173	.	
28	TC002	0	2	1	S00042	1	4	0	0	0	0	66.7	100.0	45.8	94.6	.239	.130	.010	.173	.	
29	TC002	0	2	1	S00043	1	4	0	0	0	0	73.3	100.0	45.8	94.6	.239	.130	.010	.173	.	
30	TC002	0	2	1	S00044	1	4	0	0	0	0	73.3	100.0	45.8	94.6	.239	.130	.010	.173	.	
31	TC002	0	2	1	S00045	0	1	0	0	0	1	73.3	100.0	45.8	94.6	.239	.130	.010	.173	.	
32	TC002	0	2	1	S00046	0	4	0	0	0	0	86.7	100.0	45.8	94.6	.239	.130	.010	.173	.	
33	TC004	0	2	1	S00066	0	4	1	0	0	0	18.0	82.0	66.8	98.8	.380	.450	.040	.200	652	
34	TC004	0	2	1	S00067	1	4	0	0	0	0	38.0	98.0	66.8	98.8	.380	.450	.040	.200	652	
35	TC004	0	2	1	S00068	1	4	1	0	0	0	42.0	100.0	66.8	98.8	.380	.450	.040	.200	652	
36	TC004	0	2	1	S00069	1	4	0	0	0	0	58.0	100.0	66.8	98.8	.380	.450	.040	.200	652	
37	TC004	0	2	1	S00070	1	4	0	0	0	0	60.0	100.0	66.8	98.8	.380	.450	.040	.200	652	

Quite the Data Set, but What Good is it?

Data Set has Many Useful Qualities:

- TWS completed by **all teacher candidates** (TCs) in **all programs**
- Contains **anonymized demographic data** on **K-12 learners** (*level-1 units*)
  - Gender, Race/Ethnicity, Low SES, Disability, and English Learner status
- Contains TC (*level-2 units*) data on program and degree level
- Annually, **≈ 500 TCs** teach **≈ 15,000 K-12 students** in student teaching

Many Potential Problems:

- Teacher Candidates teach **different content** for their TWS Unit
- Each classroom uses **different assessments** to measure learning
- Different instruments will have **different psychometric properties**
- Teacher-made tests tend to show **great variation in quality**

Quite the Data Set, but What Good is it?

During the year analyzed,
compiled TWS GraphMaker data contained
anonymized data for ***n* = 14,613 K-12 students**
taught by ***n* = 498 teacher candidates**.

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The Monte Carlo Simulation

Assumptions of Simulation

- Tests vary in content and domain
- Teachers select (or develop) tests aligned w/ intent to teach
- Teachers give identical (or parallel) pre and post-tests
- Teachers use tests of varying quality
- Scores follow Classical Test Theory: $X = T + E$
- Floor/ceiling effects apply to scores; $(X = 0|T < 0)$ and $(X = 100|T > 100)$
- E has random (E_r) and systematic (E_s) components ($E = E_s + E_r$)
- Within clusters, $\bar{E} = E_s$ and $\sigma_E = E_r$
- Some tests are too easy ($E_s > 0$), others too challenging ($E_s < 0$)
- Some have a lot of E_r (i.e., σ_E is very large), others are more reliable
- E is approximately normally distributed across tests ($\overline{E_s} = 0$)
- Cannot compare clusters to clusters

Research Questions / Objectives

- How does the use of different tests, with E that varies by test and by student, affect the Type I & Type II error, and bias when estimating…
  - Level-1 fixed effects?
  - Level-2 fixed effects?
  - Cross-level interaction effects?
- Develop sample-size guidelines for TWS GraphMaker data, or data which exhibits similar properties, when estimating…
  - Level-1 fixed effects
  - Level-2 fixed effects
  - Cross-level interaction effects

Monte Carlo Simulation

- Developed simulation in **SAS® Studio 3.6 (Enterprise Edition)**
- Simulation runs had *n* = **10**, **25**, **50**, **100**, or **200** Teacher Candidates
- Simulation runs had mean class sizes of *n* = **15**, *n* = **25**, or *n* = **30** students
- Generated student demographics to reflect observed data (*including co-occurrence*)

```
IF StNum <= NumELs THEN DO;
    EL = 1;
    Minority = RAND('BINOMIAL',0.9293,1);
    IF Minority = 1 THEN DO;
        LowSES = RAND('BINOMIAL',0.7417,1);
        IF LowSES = 1 THEN SWD=RAND('BINOMIAL',0.1835,1);
        ELSE SWD = RAND('BINOMIAL',0.1550,1); END;
    ELSE DO;
        LowSES = RAND('BINOMIAL',0.3421,1);
        IF LowSES = 1 THEN SWD = RAND('BINOMIAL',0.1154,1);
        ELSE SWD = RAND('BINOMIAL',0.1400,1); END; END;
ELSE DO;
    EL=0;
    Minority = RAND('BINOMIAL',0.4935,1);
    IF Minority = 1 THEN DO;
        LowSES = RAND('BINOMIAL',0.6104,1);
        IF LowSES = 1 THEN SWD = RAND('BINOMIAL',0.1400,1);
        ELSE SWD = RAND('BINOMIAL',0.0952,1); END;
    ELSE DO;
        LowSES=RAND('BINOMIAL',0.3080,1);
        IF LowSES=1 THEN SWD=RAND('BINOMIAL',0.1799,1);
        ELSE SWD=RAND('BINOMIAL',0.1059,1); END; END;
```

Monte Carlo Simulation

Pre-test scores generated such that:

$$Pre_{ij} = \gamma_{0j} + \beta_1 Minority_{ij} + \beta_2 LowSES_{ij} + \beta_3 SWD_{ij} + \beta_4 EL_{ij} + E_{ij} + \varepsilon_{ij}$$

Where

- γ_{0j} is $\sim N(45.5,\ \ 17)$
- β_1 is $\sim N(-1.9064,\ 0.5138)$
- β_2 is $\sim N(-4.1273,\ 0.5290)$
- β_3 $is \sim N(-5.5083,\ 0.6837)$
- β_4 is $\sim N(-4.7077,\ 0.6677)$
- E_{ij} is $\sim N\left(E_{s\,j},\ \ E_{r\,j}\right)$ where
  - $E_{s\,j}$ is $\sim N(0,\ \ 0.5 — 5.5)$
  - $E_{r\,j}$ is $\sim N(0.5 — 3.0,\ \ 0 — 1)$

Monte Carlo Simulation

Post-test scores generated such that:

$$Post_{ij} = \gamma_{0j} + \beta_0 Pre_{ij} + \beta_1 Minority_{ij} + \beta_2 LowSES_{ij} + \beta_3 SWD_{ij} + \beta_4 EL_{ij} + \gamma_{1j} Group_{ij} + \beta_5 EL_{ij}(Group_{ij}) + E_{ij} + \varepsilon_{ij}$$

Where

- $\beta_4 EL_{ij}$ is the level-1 effect of interest
- $\gamma_{1j} Group_{ij}$ is the level-2 effect of interest
- $\beta_5 EL_{ij}(Group_{ij})$ is the cross-level interaction effect

Simulation Replications

Variable	Conditions							
Number of TCs	10	25	50	100	200	← These 15 combinations were run 250 times for each effect size condition below (for 90,000 total runs)		
Students per TC	15	25	30					
$\beta_4 EL_{ij}$	d = 0.010 (0.182)	d = 0.025 (0.455)	d = 0.050 (0.909)	d = 0.100 (1.819)	d = 0.200 (3.637)	d = 0.300 (5.456)	d = 0.400 (7.275)	d = 0.500 (9.094)
$\gamma_{1j} Group_{ij}$	d = 0.010 (0.179)	d = 0.025 (0.448)	d = 0.050 (0.897)	d = 0.100 (1.793)	d = 0.200 (3.586)	d = 0.300 (5.380)	d = 0.400 (7.173)	d = 0.500 (8.966)
$\beta_5 EL_{ij}(Group_{ij})$	d = 0.010 (0.182)	d = 0.025 (0.456)	d = 0.050 (0.912)	d = 0.100 (1.824)	d = 0.200 (3.649)	d = 0.300 (5.473)	d = 0.400 (7.298)	d = 0.500 (9.122)

Type I Error Rates

Level-1 Fixed Effects TCs (Lvl-2)	Class Size			
	15	25	30	Total
10	0.048	0.046	0.070	**0.055**
25	0.054	0.052	0.058	**0.055**
50	0.050	0.046	0.070	**0.055**
100	0.050	0.038	0.062	**0.050**
200	0.048	0.054	0.072	**0.058**
Total	**0.050**	**0.047**	**0.066**	**0.055**

Type I Error Rates

Level-2 Fixed Effects TCs (Lvl-2)	Class Size			
	15	25	30	Total
10	0.044	0.056	0.054	**0.051**
25	0.058	0.032	0.064	**0.051**
50	0.052	0.040	0.056	**0.049**
100	0.048	0.050	0.044	**0.047**
200	0.056	0.048	0.044	**0.049**
Total	**0.052**	**0.045**	**0.052**	**0.050**

Type I Error Rates

Cross-Level Interaction TCs (Lvl-2)	Class Size			
	15	25	30	Total
10	0.066	0.058	0.048	**0.057**
25	0.062	0.048	0.076	**0.062**
50	0.062	0.072	0.080	**0.071**
100	0.052	0.048	0.064	**0.055**
200	0.054	0.052	0.082	**0.063**
Total	**0.059**	**0.056**	**0.070**	**0.062**

Type II Error Rates

TCs (Lvl-2)	*d* = 0.010	*d* = 0.025	*d* = 0.050	*d* = 0.100	*d* = 0.200	*d* = 0.300	*d* = 0.400	*d* = 0.500	
Class Size	-0.182	-0.455	-0.909	-1.819	-3.637	-5.456	-7.275	-9.094	Total
10									
15	0.960	0.920	0.864	0.680	0.272	0.056	0.008	0.004	0.471
25	0.912	0.912	0.892	0.596	0.164	0.020	—	—	0.437
30	0.940	0.912	0.792	0.540	0.068	0.012	—	0.004	0.409
10 Total	**0.937**	**0.915**	**0.849**	**0.605**	**0.168**	**0.029**	**0.003**	**0.003**	**0.439**
25									
15	0.912	0.856	0.792	0.444	0.044	—	—	—	0.381
25	0.940	0.876	0.720	0.276	0.012	—	—	—	0.353
30	0.944	0.860	0.648	0.196	0.008	—	—	—	0.332
25 Total	**0.932**	**0.864**	**0.720**	**0.305**	**0.021**	**—**	**—**	**—**	**0.355**
50									
15	0.916	0.868	0.680	0.176	—	—	—	—	0.330
25	0.912	0.768	0.512	0.108	0.004	—	—	—	0.288
30	0.900	0.812	0.456	0.036	—	—	—	—	0.276
50 Total	**0.909**	**0.816**	**0.549**	**0.107**	**0.001**	**—**	**—**	**—**	**0.298**
100									
15	0.900	0.760	0.368	0.040	—	—	—	—	0.259
25	0.904	0.612	0.224	0.008	—	—	—	—	0.219
30	0.884	0.616	0.164	0.012	—	—	—	—	0.210
100 Total	**0.896**	**0.663**	**0.252**	**0.020**	**—**	**—**	**—**	**—**	**0.229**
200									
15	0.900	0.596	0.132	—	—	—	—	—	0.204
25	0.756	0.416	0.084	—	—	—	—	—	0.157
30	0.760	0.356	0.048	—	—	—	—	—	0.146
200 Total	**0.805**	**0.456**	**0.088**	**—**	**—**	**—**	**—**	**—**	**0.169**
Grand Total	**0.896**	**0.743**	**0.492**	**0.207**	**0.038**	**0.006**	**0.001**	**0.001**	**0.298**

Level-1 Fixed Effect

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Type II Error Rates

TCs (Lvl-2)	*d* = 0.010	*d* = 0.025	*d* = 0.050	*d* = 0.100	*d* = 0.200	*d* = 0.300	*d* = 0.400	*d* = 0.500	
Class Size	0.179	0.448	0.897	1.793	3.586	5.38	7.173	8.966	Total
10									
15	0.932	0.948	0.960	0.944	0.908	0.880	0.860	0.764	0.900
25	0.932	0.920	0.964	0.952	0.928	0.892	0.816	0.744	0.894
30	0.956	0.948	0.920	0.964	0.912	0.860	0.812	0.756	0.891
10 Total	**0.940**	**0.939**	**0.948**	**0.953**	**0.916**	**0.877**	**0.829**	**0.755**	**0.895**
25									
15	0.940	0.952	0.948	0.948	0.864	0.760	0.544	0.356	0.789
25	0.924	0.928	0.948	0.928	0.848	0.736	0.516	0.416	0.781
30	0.944	0.952	0.948	0.908	0.836	0.776	0.580	0.392	0.792
25 Total	**0.936**	**0.944**	**0.948**	**0.928**	**0.849**	**0.757**	**0.547**	**0.388**	**0.787**
50									
15	0.968	0.928	0.912	0.876	0.728	0.588	0.260	0.112	0.672
25	0.956	0.988	0.960	0.928	0.784	0.532	0.268	0.128	0.693
30	0.952	0.964	0.920	0.872	0.712	0.504	0.284	0.152	0.670
50 Total	**0.959**	**0.960**	**0.931**	**0.892**	**0.741**	**0.541**	**0.271**	**0.131**	**0.678**
100									
15	0.944	0.956	0.952	0.808	0.552	0.188	0.092	0.004	0.562
25	0.940	0.944	0.928	0.820	0.584	0.280	0.044	0.008	0.569
30	0.924	0.972	0.920	0.840	0.520	0.248	0.012	0.004	0.555
100 Total	**0.936**	**0.957**	**0.933**	**0.823**	**0.552**	**0.239**	**0.049**	**0.005**	**0.562**
200									
15	0.956	0.944	0.892	0.704	0.280	0.020	—	—	0.475
25	0.944	0.936	0.884	0.780	0.240	0.036	—	—	0.478
30	0.928	0.944	0.908	0.688	0.280	0.032	0.008	—	0.474
200 Total	**0.943**	**0.941**	**0.895**	**0.724**	**0.267**	**0.029**	**0.003**	**—**	**0.475**
Grand Total	**0.943**	**0.948**	**0.931**	**0.864**	**0.665**	**0.489**	**0.340**	**0.256**	**0.679**

Level-2 Fixed Effect

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Type II Error Rates

TCs (Lvl-2)	*d* = 0.010	*d* = 0.025	*d* = 0.050	*d* = 0.100	*d* = 0.200	*d* = 0.300	*d* = 0.400	*d* = 0.500	
Class Size	0.182	0.456	0.912	1.824	3.649	5.473	7.298	9.122	Total
10									
15	0.920	0.948	0.844	0.832	0.580	0.184	0.076	0.036	0.553
25	0.916	0.916	0.868	0.740	0.328	0.108	0.052	0.012	0.493
30	0.916	0.936	0.876	0.744	0.320	0.128	0.020	0.004	0.493
10 Total	**0.917**	**0.933**	**0.863**	**0.772**	**0.409**	**0.140**	**0.049**	**0.017**	**0.513**
25									
15	0.936	0.936	0.864	0.692	0.164	0.032	0.008	—	0.454
25	0.908	0.892	0.808	0.456	0.080	0.004	—	—	0.394
30	0.900	0.844	0.776	0.456	0.044	0.016	—	—	0.380
25 Total	**0.915**	**0.891**	**0.816**	**0.535**	**0.096**	**0.017**	**0.003**	**—**	**0.409**
50									
15	0.932	0.872	0.812	0.392	0.032	—	—	—	0.380
25	0.916	0.868	0.652	0.216	0.012	—	—	—	0.333
30	0.880	0.844	0.576	0.160	0.016	—	—	—	0.310
50 Total	**0.909**	**0.861**	**0.680**	**0.256**	**0.020**	**—**	**—**	**—**	**0.341**
100									
15	0.916	0.852	0.600	0.136	—	—	—	—	0.313
25	0.864	0.740	0.452	0.072	—	—	—	—	0.266
30	0.816	0.664	0.388	0.036	0.004	—	—	—	0.239
100 Total	**0.865**	**0.752**	**0.480**	**0.081**	**0.001**	**—**	**—**	**—**	**0.273**
200									
15	0.884	0.680	0.348	0.020	—	—	—	—	0.242
25	0.820	0.556	0.212	0.012	—	—	—	—	0.200
30	0.796	0.536	0.176	0.004	—	—	—	—	0.189
200 Total	**0.833**	**0.591**	**0.245**	**0.012**	**—**	**—**	**—**	**—**	**0.210**
Grand Total	**0.888**	**0.806**	**0.617**	**0.331**	**0.105**	**0.031**	**0.010**	**0.003**	**0.349**

Cross-Level Interaction

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Magnitude of Parameter Bias

TCs (Lvl-2)	*d* = 0.010	*d* = 0.025	*d* = 0.050	*d* = 0.100	*d* = 0.200	*d* = 0.300	*d* = 0.400	*d* = 0.500	
Class Size	-0.182	-0.455	-0.909	-1.819	-3.637	-5.456	-7.275	-9.094	Total
10									
15	1.010	1.132	1.092	1.052	1.168	1.121	1.107	1.247	0.471
25	0.922	0.994	0.955	0.961	0.944	0.980	0.960	1.036	0.437
30	0.827	0.854	0.862	0.850	0.853	0.842	0.946	0.979	0.409
10 Total	**0.920**	**0.993**	**0.970**	**0.954**	**0.989**	**0.981**	**1.004**	**1.087**	**0.439**
25									
15	0.750	0.788	0.641	0.729	0.702	0.678	0.717	0.753	0.381
25	0.570	0.563	0.626	0.627	0.582	0.569	0.617	0.604	0.353
30	0.564	0.536	0.575	0.497	0.520	0.603	0.560	0.584	0.332
25 Total	**0.628**	**0.629**	**0.614**	**0.618**	**0.601**	**0.617**	**0.631**	**0.647**	**0.355**
50									
15	0.534	0.500	0.465	0.504	0.495	0.488	0.520	0.554	0.330
25	0.385	0.436	0.391	0.432	0.408	0.429	0.430	0.421	0.288
30	0.376	0.346	0.376	0.384	0.398	0.386	0.423	0.432	0.276
50 Total	**0.432**	**0.427**	**0.411**	**0.440**	**0.434**	**0.434**	**0.458**	**0.469**	**0.298**
100									
15	0.356	0.360	0.347	0.352	0.416	0.345	0.400	0.394	0.259
25	0.261	0.286	0.286	0.296	0.281	0.334	0.328	0.323	0.219
30	0.263	0.264	0.243	0.270	0.258	0.242	0.278	0.293	0.210
100 Total	**0.293**	**0.303**	**0.292**	**0.306**	**0.318**	**0.307**	**0.335**	**0.337**	**0.229**
200									
15	0.244	0.251	0.242	0.258	0.248	0.252	0.268	0.260	0.204
25	0.213	0.202	0.200	0.191	0.220	0.200	0.215	0.237	0.157
30	0.195	0.203	0.186	0.194	0.181	0.202	0.210	0.201	0.146
200 Total	**0.217**	**0.218**	**0.209**	**0.214**	**0.216**	**0.218**	**0.231**	**0.233**	**0.169**
Grand Total	**0.498**	**0.514**	**0.499**	**0.506**	**0.512**	**0.511**	**0.532**	**0.555**	**0.298**

Level-1 Fixed Effect

Magnitude of Parameter Bias

TCs (Lvl-2)	*d* = 0.010	*d* = 0.025	*d* = 0.050	*d* = 0.100	*d* = 0.200	*d* = 0.300	*d* = 0.400	*d* = 0.500	
Class Size	0.179	0.448	0.897	1.793	3.586	5.38	7.173	8.966	Total
10									
15	4.529	4.557	4.502	4.543	4.813	4.049	4.399	4.477	4.484
25	5.155	5.055	4.564	4.478	4.445	4.749	4.455	4.582	4.685
30	4.629	4.416	4.885	4.232	5.129	4.842	4.303	4.502	4.617
10 Total	**4.771**	**4.676**	**4.650**	**4.417**	**4.796**	**4.547**	**4.386**	**4.520**	**4.596**
25									
15	3.013	2.866	2.875	3.059	2.884	2.776	3.005	2.840	2.915
25	3.102	3.088	3.063	2.935	2.801	2.941	2.991	3.017	2.992
30	3.071	2.942	3.109	3.069	3.024	2.787	3.012	2.897	2.989
25 Total	**3.062**	**2.965**	**3.016**	**3.021**	**2.903**	**2.835**	**3.003**	**2.918**	**2.965**
50									
15	1.952	2.144	2.109	2.302	2.048	1.999	1.974	1.921	2.056
25	2.079	1.717	1.944	1.942	2.084	2.220	1.961	2.163	2.014
30	2.041	1.982	2.095	2.151	2.172	1.892	2.187	2.266	2.098
50 Total	**2.024**	**1.948**	**2.049**	**2.132**	**2.102**	**2.037**	**2.041**	**2.117**	**2.056**
100									
15	1.514	1.440	1.393	1.604	1.458	1.451	1.705	1.612	1.522
25	1.568	1.488	1.485	1.548	1.392	1.631	1.541	1.452	1.513
30	1.531	1.300	1.485	1.468	1.453	1.534	1.450	1.707	1.491
100 Total	**1.538**	**1.409**	**1.454**	**1.540**	**1.434**	**1.539**	**1.565**	**1.591**	**1.509**
200									
15	1.026	1.057	1.051	1.074	1.046	1.086	1.038	1.174	1.069
25	1.022	1.087	1.088	0.989	1.009	1.125	1.119	1.241	1.085
30	1.078	1.114	1.052	1.091	1.117	1.088	1.196	1.265	1.125
200 Total	**1.042**	**1.086**	**1.064**	**1.051**	**1.057**	**1.100**	**1.118**	**1.227**	**1.093**
Grand Total	**2.487**	**2.417**	**2.447**	**2.432**	**2.458**	**2.411**	**2.422**	**2.474**	**2.444**

Level-2 Fixed Effect

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Magnitude of Parameter Bias

TCs (Lvl-2)	*d* = 0.010	*d* = 0.025	*d* = 0.050	*d* = 0.100	*d* = 0.200	*d* = 0.300	*d* = 0.400	*d* = 0.500	
Class Size	0.182	0.456	0.912	1.824	3.649	5.473	7.298	9.122	Total
10									
15	1.644	1.688	1.664	1.509	1.680	1.510	1.617	1.700	1.627
25	1.350	1.488	1.317	1.225	1.267	1.318	1.423	1.419	1.351
30	1.333	1.150	1.196	1.241	1.295	1.286	1.256	1.288	1.255
10 Total	**1.442**	**1.442**	**1.392**	**1.325**	**1.414**	**1.371**	**1.432**	**1.469**	**1.411**
25									
15	0.994	0.918	0.921	0.922	0.996	1.032	1.125	1.097	1.001
25	0.854	0.884	0.806	0.775	0.838	0.876	0.842	0.861	0.842
30	0.770	0.844	0.734	0.770	0.710	0.734	0.778	0.839	0.773
25 Total	**0.873**	**0.882**	**0.820**	**0.822**	**0.848**	**0.881**	**0.915**	**0.932**	**0.872**
50									
15	0.715	0.722	0.666	0.684	0.718	0.719	0.742	0.879	0.731
25	0.536	0.565	0.558	0.587	0.553	0.523	0.648	0.693	0.583
30	0.569	0.497	0.630	0.540	0.556	0.585	0.579	0.686	0.580
50 Total	**0.607**	**0.595**	**0.618**	**0.604**	**0.609**	**0.609**	**0.657**	**0.753**	**0.631**
100									
15	0.520	0.452	0.475	0.498	0.501	0.513	0.576	0.666	0.525
25	0.476	0.444	0.439	0.409	0.418	0.420	0.476	0.541	0.453
30	0.432	0.422	0.364	0.401	0.367	0.403	0.469	0.503	0.420
100 Total	**0.476**	**0.440**	**0.426**	**0.436**	**0.429**	**0.445**	**0.507**	**0.570**	**0.466**
200									
15	0.343	0.396	0.357	0.388	0.366	0.386	0.478	0.509	0.403
25	0.327	0.308	0.322	0.286	0.303	0.314	0.377	0.470	0.338
30	0.324	0.286	0.310	0.289	0.300	0.281	0.339	0.471	0.325
200 Total	**0.331**	**0.330**	**0.330**	**0.321**	**0.323**	**0.327**	**0.398**	**0.483**	**0.355**
Grand Total	**0.746**	**0.738**	**0.717**	**0.702**	**0.725**	**0.727**	**0.782**	**0.841**	**0.747**

Cross-Level Interaction

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Take-Aways From These Findings

- Type I error rates are slightly inflated, but inflation is unrelated to any known (or manipulable) parameter
  - Consider using a more conservative alpha level
- Type II error rate indicates a need for increased sample size
  - Level-1 units within clusters must be sufficient to draw within-cluster inferences, ***and***
  - Level-2 units must support inferences drawn across clusters
- Magnitude of bias decreases with additional level-2 units

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Methodological Application

Differentiated ESOL Preparation

Table 2

Number of Courses (Number of Assignments in Parentheses) with English Learner-Related Coursework for Groups 1 and 2

	Group 1			Group 2		
	Mathematics	Science	Social Studies	English Language Arts	Elementary	Early Childhood
Core Classes	5 (12)	5 (12)	5 (12)	5 (12)	5 (12)	5 (12)
EL Standalone	1 (3)	1 (3)	1 (3)	2 (11)	2 (11)	2 (11)
Specialization	0 (0)	0 (0)	0 (0)	5 (18)	8 (19)	9 (27)
Total	6 (15)	6 (15)	6 (15)	12 (41)	15 (42)	16 (50)

Note: EL standalone courses are devoted entirely to English learner content (second language acquisition, methods of teaching English as a second language, English language development) while the other courses listed contain specific designated materials and related assignments that infuse EL content into the content typically associated with those courses. Teacher candidates in Group 2 are required to work with ELs during internship, while Group 1 teacher candidates are not.

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Research Question

Are English Learner unit post-assessment scores related to whether the teacher candidate is enrolled in a Group 1 or Group 2 EL-infused teacher preparation program, after controlling for student pre-assessment score, disability status, minority status, and qualification for free / reduced price lunch?

Sample and Data Set

- Data set was restricted to:
  - Academic subject teacher candidates
  - Reported all variables for ≥ 10 students
  - Taught both ELs and non-ELs
- Final data set contained:
  - 6,812 K-12 Students (M = 6,812)
  - 244 Teacher Candidates (N = 244)
  - Clusters of from 10 to 145 students ($\bar{n}$ = 27.9, SD = 23.2)
  - n = 1075 English Learners (15.8%)
  - From 1 to 56 ELs per cluster ($\bar{n}$ = 4.4, SD = 6.2)

Multilevel Model Analyzed with SAS PROC MIXED

$$Post_{ij} = \gamma_{00} + \beta_{1j}Pre_{ij} + \beta_{2j}Minority_{ij} + \gamma_{30}EL_{ij} + \gamma_{40}SWD_{IJ} + \beta_{5j}LowSES_{ij} + \gamma_{01}Group_j + \beta_{6j}EL_{ij}Group_j + \left(u_{3j}EL_{ij} + u_{4j}SWD_{ij} + u_{0j} + r_{ij}\right)$$

Results

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	65.4688	1.5159	258	43.19	<.0001
Pre	0.3318	0.0097	6600	34.22	<.0001
EL	**0.1626**	**1.3568**	**79.8**	**0.12**	**0.9049**
SWD	-5.4901	0.7432	111	-7.39	<.0001
LowSES	-2.6336	0.4260	6773	-6.18	<.0001
Minority	-1.5083	0.4142	6611	-3.64	0.0003
Group	5.4529	1.6211	224	3.36	0.0009
EL*Group	**-1.5784**	**1.5526**	**92.2**	**-1.02**	**0.3120**

Normal Curve Equivalent Results

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	32.1204	0.7643	6790	42.03	<.0001
PreNCE	0.4083	0.01105	6790	36.96	<.0001
EL	**0.1191**	**1.0772**	**6790**	**0.11**	**0.9119**
SWD	-5.5257	0.6657	6790	-8.30	<.0001
LowSES	-2.1050	0.4821	6790	-4.37	<.0001
Minority	-1.5209	0.5001	6790	-3.04	0.0024
Group	0.4965	0.5034	6790	0.99	0.3240
EL*Group	**-2.1634**	**1.3031**	**6790**	**-1.66**	**0.0969**

Take-Aways From These Findings

- ELs have significantly lower pre-assessment scores, even after controlling for disability status, SES, and minority status
- Differences in post-assessment scores for Els are better explained by disability, SES, and minority status than EL status
- Teacher Candidates in both groups are equally well-prepared to teach their respective content to Els
- Classroom assessments can be aggregated to investigate certain kinds of research and evaluation questions

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THANK YOU! QUESTIONS?

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