

The Role of Formative Assessment in Student Learning: Multi-level Analyses

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Outline

- Research questions
- Study samples
- Study methods, analyses and findings
- Conclusions



Research Questions

1. To What Extent Does the Treatment Affect Student Learning?
2. How and in What Ways Does Fidelity of Implementation Affect Student Learning?
3. What Factors Influence Learning Outcomes?



Study Variables & Instrumentation

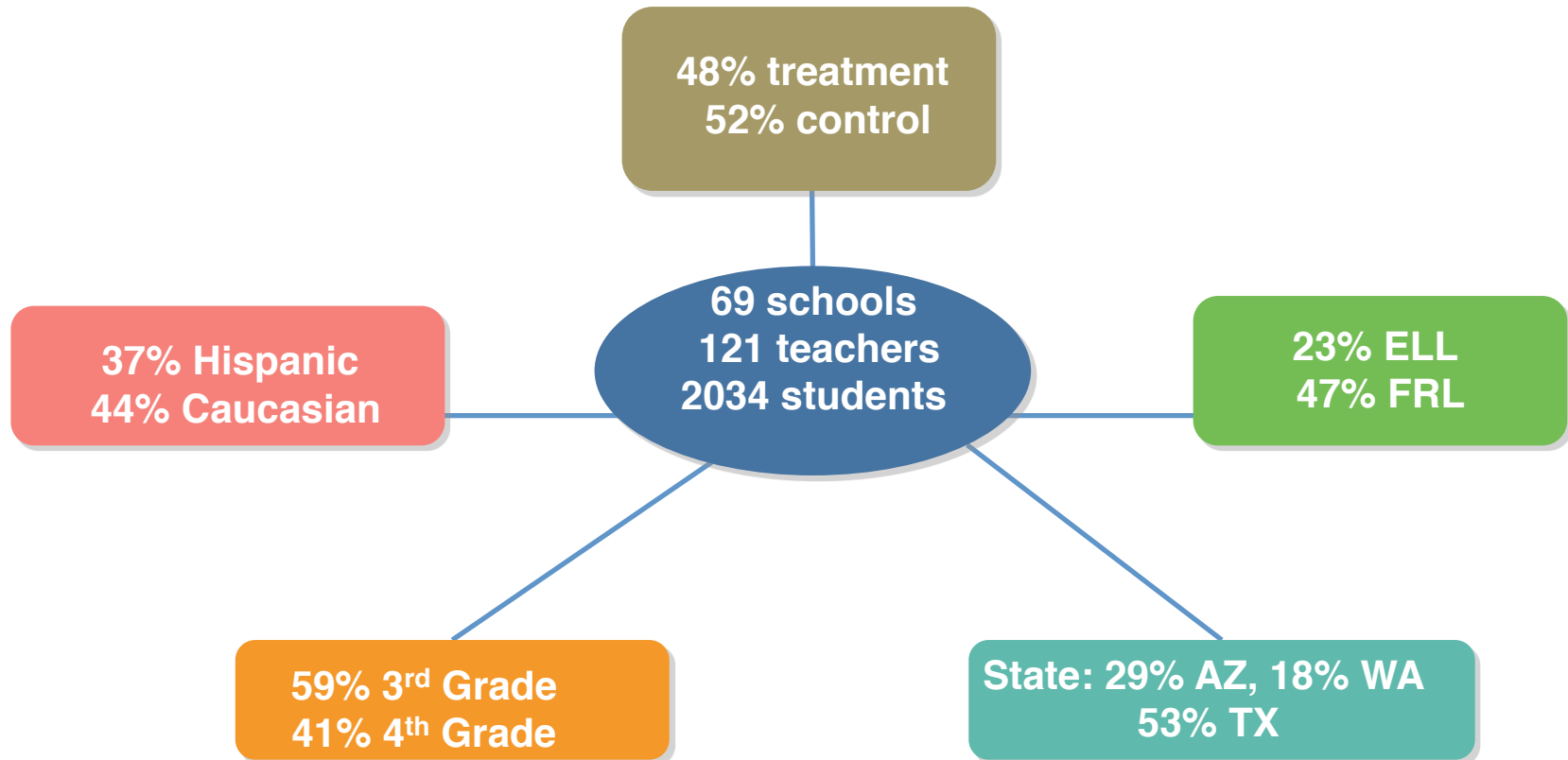
Students

- Knowledge of magnetism and electricity: pre-post measure
- Demographics and prior achievement state, grade level: archival data

Teachers

- Quality assessment tools: treatment condition
- Teacher content knowledge: pre-post measure
- Intensity of curriculum implementation: weekly teacher log
- Frequency of on-going assessment: weekly teacher log

Description of Study Sample



Descriptive Results

	N	Mean	Std. Deviation
Total number of teacher logs	121	7.50	2.39
Total number of days teach ASK/ FOSS per week	121	3.14	0.78
Average minutes of teaching ASK/ FOSS	121	49.52	11.78
Average minutes of reviewing student work	121	9.98	5.98
Teacher pretest score	121	42.53	9.64
Student pretest score (M&E)	2034	18.75	4.96
Student posttest score (M&E)	2034	30.57	5.18

Study Methods

Multilevel regression analyses (HLM): random intercept model

- Level 1: student (i); Level 2: teacher (j); Level 3: school (k);
- Student Outcome measure = $SY_{i:j:k}$
- Student background variable = $SX_{i:j:k}$
- Teacher measure = $TX_{j:k}$
- School -level variable = ScX_k
- π : student-level (level 1) parameters/ coefficients
- β : teacher-level (level 2) parameters/ coefficients
- γ : school-level (level 3) parameters/ coefficients

HLM equation in mixed equation format

HLM equation (# of parameters/coefficients 17+3 residual)

$$\begin{aligned} SY_{i:j:k} = & \gamma_{000} + \gamma_{001} \text{Treatment}_k + \gamma_{002} \text{Grade4}_k + \gamma_{003} \text{AZ}_k \\ & + \gamma_{010} (\text{Pre_ME}_{.:j:k} - \text{Pre_ME}_{.:.:k}) + \gamma_{020} \text{Tlog_\#day}_{j:k} + \gamma_{030} \\ & \quad \text{Tlog_min_teach}_{j:k} \\ & + \gamma_{040} \text{Tlog_min_stuwork}_{j:k} + \gamma_{050} \text{Tlog_\#log}_{j:k} + \gamma_{060} \text{Tcont_oe_mag}_{j:k} \\ & + \gamma_{070} \text{Tcont_oe_elec}_{j:k} + \gamma_{080} \text{Tcont_oe_elec}_{j:k} \\ & + \gamma_{100} (\text{Pre_ME}_{i:j:k} - \text{Pre_ME}_{.:j:k}) + \gamma_{200} \text{ELL}_{i:j:k} + \gamma_{300} \text{FRL}_{i:j:k} \\ & + \gamma_{400} \text{White}_{i:j:k} + \gamma_{500} \text{Hispanic}_{i:j:k} \\ & + \epsilon_{i:j:k} + \tau_{0jk} + \mu_k \end{aligned}$$

Study Analyses and Findings

Three-level HLM Model with Teacher Content Knowledge and Log Variables (N=2035)

Solution for Fixed Effects: student M&E posttest as outcome variable					
Effect	Estimate	Standard Error	DF	t Value	Pr > t
Intercept	19.97	2.40	110	8.34	<.0001
student M&E pretest score	0.33	0.02	1916	14.51	<.0001
average student M&E pretest score per teacher	0.23	0.08	104	2.76	0.01
Treatment/control	1.46	0.68	59	2.16	0.03
AZ	0.98	0.99	65.3	0.99	0.33
grade4	-0.32	0.90	66.2	-0.36	0.72
ELL	-0.63	0.34	1562	-1.85	0.06
FRL	-0.59	0.23	1994	-2.53	0.01
Ethnicity_Caucasian	1.06	0.27	1982	3.96	<.0001
Ethnicity_Hispanic	0.42	0.28	2002	1.48	0.14
Log: Number times/week taught	1.18	0.40	101	2.96	0.00
Log: Number of minutes/day taught	0.05	0.02	110	2.11	0.04
Log: Time spent analyzing student work	-0.05	0.05	98	-1.04	0.30
Log: Number Completed	0.31	0.12	106	2.48	0.01
Teacher Content Knowledge, Pre	0.03	0.03	94.1	0.99	0.33
Overall model fit statistics	AIC=11546.5	BIC=11553.2			

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Estimated Effects of Variables on Student Post Test

- Treatment: 1.46 (0.03)
- Total days per week to teach ASK/FOSS: 1.18 (0.01)
- Average minutes teach ASK/FOSS: 0.05 (0.04)
- Number of teacher logs: 0.31 (0.01)
- Prior M&E score: 0.33 (<.0001)
- FRL status:-0.59 (0.01)
- Caucasian: 1.06 (<.0001)

Conclusions

Treatment significantly impacts students' science learning.

Study findings underscore

- the value of quality curriculum,
- teachers' use of embedded, formative assessment tools in supporting student learning.

Importance of formative assessment components in curriculum development and selection.

For More Information

- Dai, Y., Herman, J., Osmundson, E., & Chai, Y., (2013) *Multivariate Analyses of Effects from Embedded Formative Assessment on Student science Learning and Teacher assessment practices*. Presentation at Annual meeting of the American Educational Research Association, San Francisco, CA, Apr 26-May 1, 2013
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- Herman, J., Osmundson, E. & Silver, D (2010). Capturing quality in formative assessment practice: Measurement challenges. *CRESST Report #770*. Los Angeles, CA: CRESST.
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