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

- 48% treatment
- 52% control
- 37% Hispanic
- 44% Caucasian
- 23% ELL
- 47% FRL
- 69 schools
- 121 teachers
- 2034 students
- 59% 3rd Grade
- 41% 4th Grade
- State: 29% AZ, 18% WA
- 53% TX
## Descriptive Results

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of teacher logs</td>
<td>121</td>
<td>7.50</td>
<td>2.39</td>
</tr>
<tr>
<td>Total number of days teach ASK/FOSS per week</td>
<td>121</td>
<td>3.14</td>
<td>0.78</td>
</tr>
<tr>
<td>Average minutes of teaching ASK/FOSS</td>
<td>121</td>
<td>49.52</td>
<td>11.78</td>
</tr>
<tr>
<td>Average minutes of reviewing student work</td>
<td>121</td>
<td>9.98</td>
<td>5.98</td>
</tr>
<tr>
<td>Teacher pretest score</td>
<td>121</td>
<td>42.53</td>
<td>9.64</td>
</tr>
<tr>
<td>Student pretest score (M&amp;E)</td>
<td>2034</td>
<td>18.75</td>
<td>4.96</td>
</tr>
<tr>
<td>Student posttest score (M&amp;E)</td>
<td>2034</td>
<td>30.57</td>
<td>5.18</td>
</tr>
</tbody>
</table>
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 \(= ScX_k\)

• \(\pi\): student-level (level 1) parameters/coefficients
• \(\beta\): teacher-level (level 2) parameters/coefficients
• \(\gamma\): school-level (level 3) parameters/coefficients
HLM equation in mixed equation format

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

\[ SY_{i:j:k} = \gamma_{000} + \gamma_{001} \text{Treatment}_k + \gamma_{002} \text{Grade4}_k + \gamma_{003} \text{AZ}_k \]

\[ + \gamma_{010} (\text{Pre}_i\text{ME}_{:.j:k} - \text{Pre}_i\text{ME}_{.::.k}) + \gamma_{020} \text{Tlog}_{#\text{day}_{j:k}} + \gamma_{030} \text{Tlog}_{\text{min} \text{teach}_{j:k}} \]

\[ + \gamma_{040} \text{Tlog}_{\text{min} \text{stuwork}_{j:k}} + \gamma_{050} \text{Tlog}_{#\text{log}_{j:k}} + \gamma_{060} \text{Tcont}_{oe \text{mag}_{j:k}} \]

\[ + \gamma_{070} \text{Tcont}_{oe \text{elec}_{j:k}} + \gamma_{080} \text{Tcont}_{oe \text{elecmag}_{j:k}} \]

\[ + \gamma_{100} (\text{Pre}_i\text{ME}_{i:j:k} - \text{Pre}_i\text{ME}_{.:j:k}) + \gamma_{200} \text{ELL}_{i:j:k} + \gamma_{300} \text{FRL}_{i:j:k} \]

\[ + \gamma_{400} \text{White}_{i:j:k} + \gamma_{500} \text{Hispanic}_{i:j:k} \]

\[ + \epsilon_{i:j:k} + \tau_{0jk} + \mu_k \]
### Study Analyses and Findings

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

| 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           | 653 | 0.99     | 0.33  |
| grade4                                      | -0.32    | 0.90           | 662 | -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 |     |          |      |
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


