Using HLM to Assess Math Achievement

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Theoretical Framework

1. Using the pedagogy of gifted education (i.e., flexible ability grouping, differentiation) may enhance the math achievement of all students; and
2. Marsh (1986) suggests that high ability students may suffer decline in self-concepts when grouped with students of similar or advanced capabilities.

Purpose of the Study

1. to examine the effects of student- and school-level variables on grade 4 and 5 students’ mathematics achievement; and
2. to analyze the effects of average classroom or school achievement on students’ self-efficacy and self-concept for math.

Research Hypotheses

1. Treatment level (below-, on-, and above-grade) will be significantly and positively related to individual math achievement, self-efficacy, and self-concept;
2. After controlling for treatment levels, grouping type (whole or flexible) will be significantly and positively related to individual math achievement, self-efficacy, and self-concept;
3. After controlling for student demographic variables, average classroom and school achievement will incrementally and positively affect individual math achievement;
4. After controlling for student demographic variables, average classroom and school achievement will incrementally and positively affect individual math achievement;
5. After controlling for student demographic variables, average classroom and school achievement will incrementally and positively affect individual math achievement;
6. After controlling for student demographic variables, average classroom and school achievement will incrementally and positively affect individual math achievement.

Research Questions

1. How much variation in students’ posttest CBA scores is attributable to individual differences?
2. How much variation in students’ posttest CBA scores is attributable to school membership?
Method

- **Sample**
  - The sample consisted of 34 teachers and their students (N = 420), randomly assigned to one of three treatment levels (below, on, or above grade level) based on their pretest scores on a curriculum-based assessment (CBA).

- **Instrumentation**
  - Curriculum-Based Assessment (alpha = .78), developed for this study.
  - Student Mathematics Self-Efficacy Survey (SMSES) (alpha = .91) (adapted from Siegle, 1995).
  - Academic Self-Concept (alpha = .85) (adapted from Marsh, 1990).
  - Student Self-Concept for Math Scale (SSCMS) (alpha = .93) (adapted from Marsh, 1990).

- **Treatment**
  - Three-week experimental math unit on Data Representation and Analysis, differentiated based on prior knowledge.

Results: RH1

- Significantly related to posttest CBA scores ($t = 8.05, p < .001$).
- Not significantly related to posttest MSE scores ($t = 2.68, p = .152$).
- Not significantly related to posttest MSC scores ($t = 1.10, p = .182$).
- Not significantly related to posttest ASC scores ($t = .995, p = .166$).

Results: RH1

<table>
<thead>
<tr>
<th>Treat</th>
<th>Group</th>
<th>CBA</th>
<th>MSE</th>
<th>MSC</th>
<th>ASC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treat</td>
<td>-</td>
<td>.132*</td>
<td>.461**</td>
<td>.257**</td>
<td>-.153</td>
</tr>
<tr>
<td>Group</td>
<td>.103**</td>
<td>-</td>
<td>.118</td>
<td>.160</td>
<td>-.084</td>
</tr>
<tr>
<td>CBA</td>
<td>.421**</td>
<td>.098*</td>
<td>-</td>
<td>.205*</td>
<td>.034</td>
</tr>
<tr>
<td>MSE</td>
<td>.174**</td>
<td>.009</td>
<td>.256**</td>
<td>-</td>
<td>.484**</td>
</tr>
<tr>
<td>MSC</td>
<td>.215**</td>
<td>.206**</td>
<td>.128*</td>
<td>.481**</td>
<td>-</td>
</tr>
<tr>
<td>ASC</td>
<td>.212**</td>
<td>.003</td>
<td>.184*</td>
<td>.451**</td>
<td>.627**</td>
</tr>
</tbody>
</table>

Note: Intercorrelations for Above-Grade Level participants are presented above the diagonal.

Means and Standard Deviations for Student Mathematics Self-Efficacy Survey by Treatment Level

<table>
<thead>
<tr>
<th>Treatment Level</th>
<th>N of Students</th>
<th>Pretest M</th>
<th>Pretest SD</th>
<th>Posttest M</th>
<th>Posttest SD</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Grade Level</td>
<td>38</td>
<td>88.24</td>
<td>23.18</td>
<td>103.24</td>
<td>13.80</td>
<td>.81</td>
</tr>
<tr>
<td>On Grade Level</td>
<td>96</td>
<td>86.52</td>
<td>19.61</td>
<td>107.01</td>
<td>18.86</td>
<td>1.06</td>
</tr>
<tr>
<td>Above Grade Level</td>
<td>94</td>
<td>87.54</td>
<td>18.78</td>
<td>110.64</td>
<td>19.86</td>
<td>1.20</td>
</tr>
<tr>
<td>Total</td>
<td>228</td>
<td>87.23</td>
<td>19.91</td>
<td>107.88</td>
<td>19.91</td>
<td>1.04</td>
</tr>
</tbody>
</table>
Results: RH2: Grouping Type

- After controlling for treatment levels, grouping (whole class or flexible) was not significantly related to posttest CBA, MSE, MSC, or ASC scores.

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Results: RH3: Class and School Achievement

- Mean class achievement was significantly related to individual posttest CBA scores ($t = 4.95, p < .001$).
- Mean school achievement was not significantly related to individual posttest CBA scores ($t = 1.61, p = .204$).

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Results: RH4: Mean Class/School Achievement and Math Self-Efficacy

- Mean class achievement was not significantly related to individual posttest MSE scores ($t = -1.67, p = .071$).
- Mean school achievement was not significantly related to individual posttest MSE scores ($t = 1.66, p = .193$).
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Results: RH5: Mean Class/School Achievement and Math Self-Concept

- Mean class achievement was not significantly related to individual posttest MSC scores ($t = .562, p = .581$).
- Mean school achievement was not significantly related to individual posttest MSC scores ($t = -1.43, p = .247$).

Results: RH5: Mean Class/School Achievement and Academic Self-Concept

- Mean class achievement was not significantly related to individual posttest ASC scores ($t = -.245, p = .809$).
- Mean school achievement was not significantly related to individual posttest ASC scores ($t = -.223, p = .838$).

Research Questions

1. How much variation in students’ posttest CBA scores is attributable to individual differences?
2. How much variation in students’ posttest CBA scores is attributable to school membership?

Research Questions

- Curriculum-Based Assessment
  - Significant variation around the mean ($\chi^2 = 66.83, p < .001$) among students.
  - Significant variation ($\chi^2 = 21.45, p < .001$) among students in schools.
  - School membership explained 25.7% variance in individual mean scores.
- Math Self-Efficacy
  - No significant variation around the mean ($\chi^2 = 13.84, p = .180$) due to individual differences among students.
  - Significant variation in students’ mean scores based on school membership ($\chi^2 = 22.03, p < .001$).
  - School membership explained approximately 7.8% of the variance in individual mean scores.

Research Questions

- Math Self-Concept
  - Significant variation ($\chi^2 = 19.39, p < .05$) due to individual differences among students.
  - Significant variation based on school membership ($\chi^2 = 17.84, p < .01$).
  - School membership explained 9.8% of the variation in individual mean scores.
- Academic Self-Concept
  - No significant variation ($\chi^2 = 3.59, p > .05$) due to individual differences among students.
  - Significant variation based on school membership ($\chi^2 = 21.01, p < .01$).
  - School membership explained 5.7% of the variation in individual mean scores.

Conclusions: Math Achievement

- Students in all treatment levels and grouping arrangements had positive gains pretest to posttest.
- Students who were enrolled in classes with high achievement levels had higher posttest scores.
- Students who were enrolled in schools with high achievement levels had slightly higher posttest scores.

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Conclusions: Math Self-Efficacy

- Students who scored on or above grade level on the pretest had higher MSE scores than their peers.
- Students who were placed into flexible groups had higher MSE scores than their peers in the whole class setting.
- Students who were in higher achieving classes had lower MSE scores.

Conclusions: Math and Academic Self-Concepts

- Students who scored on or above grade level on the pretest CBA had higher scores on posttests for MSC and ASC.
- Students who were placed into flexible groups had higher MSC and lower ASC scores than their peers in the whole class setting.
- Students who were in higher achieving classes had higher MSC and lower ASC posttest scores.
- Students who were in higher achieving schools had lower MSC and ASC posttest scores.

Limitations

- Sample sizes for the various treatment conditions were small and diverse.
- Attrition, especially for affective scales.
- Instrumentation: The CBA created for this unit was too difficult and range was restricted.
- There is evidence that a short educational intervention may bring about substantial gains that may not be sustainable over time (Kulik, 1992).

Implications

- Flexible grouping may enhance students' levels of self-efficacy.
  - Bandura (1986) suggested that one modeling cue that may activate student self-efficacy is “similarity to others.”
  - The BFLPE (Marsh, 1986) was in evidence in this study, however the effects were trivial and non-significant.
    - Class level: students had higher MSC
    - School level: students scored lower on both MSC and ASC
- Appropriate flexible grouping strategies may have a positive effect on all students.