

## Using HLM to Assess Math Achievement

Carol L. Tieso, Ph.D.  
Gifted Education  
The College of William and Mary  
[clties@wm.edu](mailto:clties@wm.edu)

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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.

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## 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.

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## 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;

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## Research Hypotheses

4. After controlling for student demographic variables, average classroom and school achievement will incrementally and positively affect math self-efficacy; and
5. After controlling for student demographic variables, average classroom and school achievement will incrementally and negatively affect math and academic self-concept.

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## 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?

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<b>Method</b>
<ul style="list-style-type: none"> <li>■ <b>Sample</b> <ul style="list-style-type: none"> <li>- 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).</li> </ul> </li> <li>■ <b>Instrumentation</b> <ul style="list-style-type: none"> <li>- Curriculum-Based Assessment (alpha = .78), developed for this study.</li> <li>- Student Mathematics Self-Efficacy Survey (SMSES) (alpha = .91) (adapted from Siegle, 1995).</li> <li>- Academic Self-Concept (alpha = .85) (adapted from Marsh, 1990).</li> <li>- Student Self-Concept for Math Scale (SSCMS) (alpha = .93) (adapted from Marsh, 1990).</li> </ul> </li> <li>■ <b>Treatment</b> <ul style="list-style-type: none"> <li>- Three-week experimental math unit on Data Representation and Analysis, differentiated based on prior knowledge.</li> </ul> </li> </ul>

<b>Data Analysis</b>
<ul style="list-style-type: none"> <li>■ <b>Descriptives</b> <ul style="list-style-type: none"> <li>- IVs                             <ul style="list-style-type: none"> <li>■ Treatment Level</li> <li>■ Grouping Type</li> </ul> </li> <li>- DVs                             <ul style="list-style-type: none"> <li>■ Curriculum-Based Assessment</li> <li>■ Academic and Math Self-Concepts</li> <li>■ Self-Efficacy for Math</li> </ul> </li> </ul> </li> <li>■ <b>HLM: 3 Level Model</b> <ul style="list-style-type: none"> <li>- Individual students</li> <li>- Classrooms</li> <li>- Schools</li> </ul> </li> </ul>

<b>Results: RH1: Treatment Level</b>
<ul style="list-style-type: none"> <li>■ Significantly related to posttest CBA scores (<math>t = 8.05, p &lt; .001</math>).</li> <li>■ Not significantly related to posttest MSE scores (<math>t = 2.68, p = .152</math>).</li> <li>■ Not significantly related to posttest MSC scores (<math>t = 1.10, p = .182</math>).</li> <li>■ Not significantly related to posttest ASC scores (<math>t = .995, p = .166</math>).</li> </ul>

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Table 4  
Means and Standard Deviations for Student Mathematics Self-Concept Survey by Treatment Level

Treatment Level	N of Students	Pretest M	Pretest SD	Posttest M	Posttest SD	<i>d</i>
Below Grade Level	113	33.22	6.60	29.48	5.75	-.61
On Grade Level	160	34.09	7.88	30.41	6.77	-.50
Above Grade Level	147	34.86	7.09	30.69	6.71	-.60
Total	420	34.13	7.29	30.26	6.49	-.56

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**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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Table 3  
Means and Standard Deviations for Student Mathematics Self-Efficacy Survey by Grouping Type

Grouping Type	N of Students	Pretest M	Pretest SD	Posttest M	Posttest SD	<i>d</i>
Whole Class	68	84.60	16.43	102.28	19.72	.98
Flexible Groups	160	88.34	21.07	110.26	19.57	1.08 (.40)
Total	228	87.23	19.84	107.88	19.91	1.04

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Table 6  
Means and Standard Deviations for Student Mathematics Self-Concept Survey by Grouping Type

Grouping Type	N of Students	Pretest M	Pretest SD	Posttest M	Posttest SD	<i>d</i>
Whole Class	174	35.89	7.13	31.36	7.01	-.63
Flexible Groups	246	32.88	7.15	29.48	5.99	-.52 (-.49)
Total	420	34.13	7.29	30.26	6.49	-.56

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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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	<b>Results: RH5: Mean Class/School Achievement and Math Self-Concept</b>
	<ul style="list-style-type: none"> <li>■ Mean <i>class</i> achievement was <i>not</i> significantly related to individual posttest MSC scores (<math>t = .562, p = .581</math>).</li> <li>■ Mean <i>school</i> achievement was <i>not</i> significantly related to individual posttest MSC scores (<math>t = -1.43, p = .247</math>).</li> </ul>
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	<b>Results: RH5: Mean Class/School Achievement and Academic Self-Concept</b>
	<ul style="list-style-type: none"> <li>■ Mean <i>class</i> achievement was <i>not</i> significantly related to individual posttest ASC scores (<math>t = -.245, p = .809</math>).</li> <li>■ Mean <i>school</i> achievement was <i>not</i> significantly related to individual posttest ASC scores (<math>t = -.223, p = .838</math>).</li> </ul>
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	<b>Research Questions</b>
	<ol style="list-style-type: none"> <li>1. How much variation in students' posttest CBA scores is attributable to individual differences?</li> <li>2. How much variation in students' posttest CBA scores is attributable to school membership?</li> </ol>
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	<b>Research Questions</b>
	<ul style="list-style-type: none"> <li>■ Curriculum-Based Assessment             <ul style="list-style-type: none"> <li>- Significant variation around the mean (<math>\chi^2 = 66.83, p &lt; .001</math>) among students.</li> <li>- Significant variation (<math>\chi^2 = 21.45, p &lt; .001</math>) among students in schools.</li> <li>- School membership explained 25.7% variance in individual mean scores.</li> </ul> </li> <li>■ Math Self-Efficacy             <ul style="list-style-type: none"> <li>- No significant variation around the mean (<math>\chi^2 = 13.84, p = .180</math>) due to individual differences among students.</li> <li>- Significant variation in students' mean scores based on school membership (<math>\chi^2 = 22.03, p &lt; .001</math>).</li> <li>- School membership explained approximately 7.8% of the variance in individual mean scores.</li> </ul> </li> </ul>
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	<b>Research Questions</b>
	<ul style="list-style-type: none"> <li>■ Math Self-Concept             <ul style="list-style-type: none"> <li>- Significant variation (<math>\chi^2 = 19.39, p &lt; .05</math>) due to individual differences among students.</li> <li>- Significant variation based on school membership (<math>\chi^2 = 17.84, p &lt; .01</math>).</li> <li>- School membership explained 9.8% of the variation in individual mean scores.</li> </ul> </li> <li>■ Academic Self-Concept             <ul style="list-style-type: none"> <li>- No significant variation (<math>\chi^2 = 3.59, p &gt; .05</math>) due to individual differences among students.</li> <li>- Significant variation based on school membership (<math>\chi^2 = 21.01, p &lt; .01</math>).</li> <li>- School membership explained 5.7% of the variation in individual mean scores.</li> </ul> </li> </ul>
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	<b>Conclusions: Math Achievement</b>
	<ul style="list-style-type: none"> <li>■ Students in all treatment levels and grouping arrangements had positive gains pretest to posttest.</li> <li>■ Students who were enrolled in classes with high achievement levels had higher posttest scores.</li> <li>■ Students who were enrolled in schools with high achievement levels had slightly higher posttest scores.</li> </ul>
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<b>Conclusions: Math Self-Efficacy</b>	
<ul style="list-style-type: none"><li>■ Students who scored on or above grade level on the pretest had higher MSE scores than their peers.</li><li>■ Students who were placed into flexible groups had higher MSE scores than their peers in the whole class setting.</li><li>■ Students who were in higher achieving classes had lower MSE scores.</li></ul>	25

<b>Conclusions: Math and Academic Self-Concepts</b>	
<ul style="list-style-type: none"><li>■ Students who scored on or above grade level on the pretest CBA had higher scores on posttests for MSC and ASC.</li><li>■ Students who were placed into flexible groups had <i>higher</i> MSC and <i>lower</i> ASC scores than their peers in the whole class setting.</li><li>■ Students who were in higher achieving classes had <i>higher</i> MSC and <i>lower</i> ASC posttest scores.</li><li>■ Students who were in higher achieving schools had <i>lower</i> MSC and ASC posttest scores.</li></ul>	26

<b>Limitations</b>	
<ul style="list-style-type: none"><li>■ Sample sizes for the various treatment conditions were small and diverse.</li><li>■ Attrition, especially for affective scales.</li><li>■ Instrumentation: The CBA created for this unit was too difficult and range was restricted.</li><li>■ There is evidence that a short educational intervention may bring about substantial gains that may not be sustainable over time (Kulik, 1992).</li></ul>	27

<b>Implications</b>	
<ul style="list-style-type: none"><li>■ Flexible grouping may enhance students' levels of self-efficacy.<ul style="list-style-type: none"><li>- Bandura (1986) suggested that one modeling cue that may activate student self-efficacy is "similarity to others."</li></ul></li><li>■ The BFLPE (Marsh, 1986) was in evidence in this study, however the effects were trivial and non-significant.<ul style="list-style-type: none"><li>- Class level: students had higher MSC</li><li>- School level: students scored lower on both MSC and ASC</li></ul></li><li>■ Appropriate flexible grouping strategies may have a positive effect on <i>all</i> students.</li></ul>	28