Faculty-Led Reform in Developmental Arithmetic: A Case Study at One Community College

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Welcome to Scaling Innovation

The Community College Research Center (CCRC) is proud to launch the website for Scaling Innovation, a research and implementation project that examines how promising instructional reforms in developmental education can be introduced, sustained, and scaled to enhance students’ learning, persistence, and academic progression. This website is designed to share insights about the ways that innovative course structures and pedagogical approaches are reshaping the teaching and learning experiences that take place in developmental education classrooms. It will feature reflections and professional learning resources created by our partners as well as commentary and research by CCRC.

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New Paper From Scaling Innovation

Strengthening Developmental Education Reforms: Evidence on Implementation Efforts From the Scaling Innovation Project

Drawing on a scan of current reform efforts as well as fieldwork at 11 colleges, this paper examines trends in developmental education reform implementation and provides a framework for strengthening reform efforts and broader institutional capacity. Learn more →
Our **challenge:** Improving outcomes for students referred to developmental mathematics
Promising reforms rethink course curricula and instructional approaches
1. What is Concepts of Numbers?

2. How do outcomes of students in Concepts compare to students in traditional arithmetic classes?

3. What are the experiences of faculty teaching Concepts?

4. What does this case study suggest about improving outcomes in developmental education and beyond?
Concepts of Numbers for Arithmetic & Prealgebra
What Are Math Faculty Really Looking For In Their Students?

- Meeting the learning outcomes for an arithmetic and prealgebra course
- Appreciating a deeper understanding of mathematics
- Acquiring confidence with their skills and applications
What Are Colleges Doing?

- Modules and mastery learning
- Elimination of developmental math coursework
- AMATYC New Life
- Statway/Quantway (Carnegie)
- New Life Project (Dana Center)
- MOOC (massive open online course)
- What will work for you?
Concepts of Numbers

All learning outcomes of a traditional arithmetic course are covered but in a different order.

Students are assessed on the same skills as the traditional arithmetic course.

Lessons proceed through concepts, using a discovery approach.
Concepts’ Guiding Principles

• Faculty become facilitators of knowledge; students learn through discovery
• New embedded skills are introduced on an as-needed basis
• If a student understands a skill and its usefulness, practice problems can be kept to a minimum
• Calculators are not used in this course
• All students can learn math

“Teach me, and I will forget. Show me, and I will remember. Involve me, and I will understand.”
Chinese Proverb
Faculty Facilitate

Students Discover

Limited Assignments

Embedded Skills

Success
Current Research Support

• How making “connections problems” are worked on:
  (Stigler, Givvin & Thompson UCLA, 2010)
Current Research Support

“What does it mean to be good at math?”

77% gave answers like these:

- “Math is just all these steps.”

- “In math, sometimes you have to just accept that that’s the way it is and there’s no reason behind it.”

- ”I don’t think [being good at math] has anything to do with reasoning. It’s all memorization.”

(Stigler, Givvin & Thompson UCLA, 2011)
Current Research Support

• A further review of math research (Hiebert & Grouws, 2007) identified two key factors in classroom instruction that promote conceptual development:

1. *Explicit attention to concepts* – connections among facts, procedures, ideas

2. *Struggle* – students spend at least some time grappling with important mathematics

Struggle For Smarts? How Eastern And Western Cultures Tackle Learning

SERP Institute - Phil Daro - Against "Answer-Getting"
Concepts of Numbers Outline

Unit 1: History of Numbers
Unit 2: The Real Number System
Unit 3: Comparisons
Unit 4: Addition
Unit 5: Subtraction
Unit 6: Multiplication
Unit 7: Division
Unit 8: Combinations
2. How do outcomes of students in *Concepts* compare to students in traditional arithmetic classes?
Quasi-Experimental Design

### I. Student-Level Characteristics

<table>
<thead>
<tr>
<th>Demographic Characteristics</th>
<th>Full Sample</th>
<th>Concepts Sample</th>
<th>Traditional Sample</th>
<th>Difference (Con-Tra)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>0.585 (0.493) †</td>
<td>0.607 (0.489)</td>
<td>0.569 (0.495)</td>
<td>0.038*</td>
</tr>
<tr>
<td>White</td>
<td>0.509 (0.5)</td>
<td>0.498 (0.5)</td>
<td>0.517 (0.5)</td>
<td>-0.019</td>
</tr>
<tr>
<td>African American</td>
<td>0.283 (0.45)</td>
<td>0.289 (0.453)</td>
<td>0.279 (0.448)</td>
<td>0.01</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.081 (0.273)</td>
<td>0.091 (0.288)</td>
<td>0.074 (0.263)</td>
<td>0.017</td>
</tr>
<tr>
<td>Asian</td>
<td>0.030 (0.169)</td>
<td>0.017 (0.131)</td>
<td>0.038 (0.19)</td>
<td>-0.020***</td>
</tr>
<tr>
<td>Age</td>
<td>23.276 (7.909)</td>
<td>23.974 (8.298)</td>
<td>22.812 (7.607)</td>
<td>1.162***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Academic Characteristics</th>
<th>Full Sample</th>
<th>Concepts Sample</th>
<th>Traditional Sample</th>
<th>Difference (Con-Tra)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESL Student</td>
<td>0.034 (0.182)</td>
<td>0.03 (0.171)</td>
<td>0.037 (0.188)</td>
<td>-0.007</td>
</tr>
<tr>
<td>Ever Dual Enrolled</td>
<td>0.036 (0.187)</td>
<td>0.037 (0.189)</td>
<td>0.036 (0.187)</td>
<td>0.001</td>
</tr>
<tr>
<td>Math CPT Score††</td>
<td>29.589 (6.637)</td>
<td>29.561 (6.908)</td>
<td>29.609 (6.452)</td>
<td>-0.048</td>
</tr>
<tr>
<td>English CPT Score</td>
<td>71.765 (18.143)</td>
<td>71.883 (17.739)</td>
<td>71.687 (18.41)</td>
<td>0.195</td>
</tr>
</tbody>
</table>

### II. Course-Level Characteristics

| By Full-time Faculty        | 0.586 (0.96) | 0.463 (0.691) | 0.668 (1.095) | -0.205***          |

| Observations                | 2,169       | 866            | 1,303          |                    |

*Significant at the 10% level **Significant at the 1% level † Standard deviations are in parentheses. †† N=2,126 for Math CPT scores and N=1,989 for English CPT scores.
Descriptive Course Outcomes

Grade Distribution

Percent

A  A-  B  B+  B- coursegrade  C  C+  D  Failure Withdraw

Concept Section  Traditional Section
Regression Analysis of Course Outcomes

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Baseline</th>
<th>Adding Covariates</th>
<th>Adding Covariates &amp; CPT Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persisted to the End of Math010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concepts (vs. traditional)</td>
<td>0.194*** (0.019)</td>
<td>0.243*** (0.033)</td>
<td>0.246*** (0.035)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.034</td>
<td>0.059</td>
<td>0.075</td>
</tr>
<tr>
<td>Observations</td>
<td>2,169</td>
<td>2,169</td>
<td>1,964</td>
</tr>
<tr>
<td>Completed Math010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concepts (vs. traditional)</td>
<td>0.196*** (0.021)</td>
<td>0.227*** (0.037)</td>
<td>0.246*** (0.040)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.027</td>
<td>0.080</td>
<td>0.104</td>
</tr>
<tr>
<td>Observations</td>
<td>2,169</td>
<td>2,169</td>
<td>1,964</td>
</tr>
<tr>
<td>Among CoursePersisters, Completed Math010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concepts (vs. traditional)</td>
<td>0.061*** (0.021)</td>
<td>0.038 (0.036)</td>
<td>0.061* (0.038)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.005</td>
<td>0.071</td>
<td>0.104</td>
</tr>
<tr>
<td>Observations</td>
<td>1,476</td>
<td>1,476</td>
<td>1,320</td>
</tr>
</tbody>
</table>

*Significant at the 10% level **Significant at the 5% level ***Significant at the 1% level
3. What are the experiences of faculty teaching Concepts?
Implementation Study

• 11 interviews with faculty teaching Concepts
• Observations of 3 faculty development activities at MCCC
• Analysis of institutional, curricular and professional development documents, including written faculty reflections
Launching and Scaling Concepts

• Critical need for professional learning and support
  – I have been doing more in-class conversations, but when it comes to the discovery approach, I’m not sure.
  – I’m trying to set them up for success. It’s hard to know how much [lecture] they need.

• Importance of infrastructure for in-depth and ongoing learning
  – When I first went through the orientation, I wasn’t ready to hear it.
Concepts of Numbers – Networking Educators’ Collaborative Thoughts

- One-semester commitment
- Offered input on textbook revisions
- Contributed to learning assessment process
- Provided feedback on orientation materials
- Viewed and discussed classroom video
- Electronic journal for regular reflections
- Non-evaluative peer observations
- Read and discussed articles on math pedagogy
- Culminating reflective paper
4. What does this case study suggest about improving outcomes in developmental education and beyond?
Subsequent outcomes suggest the need to look beyond course-level reform to improve learning at every stage of a student’s college career.
Features of Faculty Learning in CON-NECT

- Faculty-initiated and led
- Meaningful
- Contextualized
- Reflective
- Structured
For more information

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