PROJECT CIFOR:
USING ARCHIVAL DATA TO CLOSE THE RESEARCH-TO-PRACTICE GAP

Study: "Investigating Dosages of Student Practice during Explicit Mathematics Instruction"

Society for Research on Educational Effectiveness 2018 Conference
February 28 – March 3, 2018 – Washington, DC

Brian Gearin – University of Oregon
Chris Doabler – University of Texas at Austin
Scott Baker – Southern Methodist University
Mike Stoolmiller – Michigan State University
Patrick Kennedy – University of Oregon
Ben Clarke – University of Oregon
Nancy Nelson – University of Oregon
Hank Fien – University of Oregon

PROJECT BACKGROUND

One way to address the research-to-practice gap in education is to develop research programs that balance generalizability with practicality and scalability. Project CIFOR, an on-going National Center on Education Statistics Goal 1 Exploration project, is an example of one such program. The purpose of CIFOR is to analyze archival data from three Institute of Education Sciences (IES) Goal 3 Efficacy Trials, and a fourth grant funded under the IES Evaluation of State and Local Education Programs and Policies competition:

- *Enhancing Core Reading Instruction* (ECRI; Baker, Fien, Smolkowski, Santoro, & Smith, 2015)
- *Early Learning in Mathematics* (ELM; Baker, Chard, Clarke, Smolkowski, & Fien, 2008)
- *Systematic &Explicit Teaching Routines* (SETR; Baker, Linan-Thompson, Santoro, & Baker, 2007)
- *Middle School Intervention Project* (MSIP; Baker, Crone, & Fien, 2010).

Whereas the IES-funded projects evaluated overall impact, CIFOR is aimed at investigating mediating and moderating variables. As such, the project facilitates inquiry into malleable factors that affect the generalizability, practicality, and scalability of academic interventions.

PROJECT AIMS

- **Aim1** Investigate the relationship between the quantity of instruction, the rate of instructional interactions, and classroom quality with beginning-of-year and end-of-year student achievement in reading and math
- **Aim 2** Investigate the relationship between the latent quantity, rate, and quality constructs with classroom characteristics
- **Aim 3** Investigate the potential moderating roles of rate and quality on the relationship between quantity and end of year student achievement in reading and math
- **Aim 4** Investigate the potential 3-way interaction between BOY student achievement, rate or quality, and quantity on end of year student achievement in reading and math

OTHER CIFOR FINDINGS

- In Doabler et al. (2017a), a mediation analysis of ELM found evidence that the rate in which teachers facilitated individual student practice opportunities during core mathematics instruction explained the program's differential effectiveness.
- In Doabler et al. (2017b), a mediation analysis found evidence that ELM significantly increases teacher use of effective instructional practices, especially providing individual and group practice opportunities. Experience using ELM was associated with increased rates of instructional interactions.

DOSAGES OF STUDENT PRACITCE IN ELM (AIMS 1 & 2)

Explicit mathematics instruction can be an effective means for promoting mathematics learning among the general student population, and among students with mathematics difficulties (MD). One of the features hypothesized to contribute to the efficacy of explicit mathematics programs is the student practice opportunities they facilitate around critical mathematics concepts and skills. In this study, we sought to answer two questions:

(1) Is there a particular dosage or number of student practice opportunities (i.e., threshold) that demonstrates a limited effect on the mathematics achievement of students with MD?

(2) Are commonly used dosages of student practice in core mathematics instruction associated with the mathematics achievement of students with MD?

METHOD

Design and Setting:

- Data Source: ELM efficacy trial, which took place in Oregon and Texas during the 2008-2009 and 2009-2010 respectively
  - Note: this study does not include tests of experimental condition

Classrooms and Teachers:

- Recruited 129 classrooms across 46 schools from Oregon and Texas: (32 public, 11 private, and 3 charter). All charter and private schools were from Texas
- 130 teachers (98% female; 69% White, 20% Hispanic, and 11% another ethnic group), 39% held a graduate degree, 51% completed college-level coursework in algebra, and most had < 7 years of teaching experience

Students

- 2,708 kindergarten students (47.3% female)
  - Approximately 50% at risk for MD at start of the kindergarten year
  - 56.7% White, 16.3% African American, 15.3% American Indian, 8.3% Asian
  - 76% eligible for free or reduced price lunch programs
  - 29% had limited English proficiency and 5% received special ed. services

Student Math Outcome Measures: (administered in fall [pre] and spring [post])

- *Test of Mathematics Ability – Third Edition* (TEMA-3; Ginsburg & Baroody, 2003)
- *Early Numeracy Curriculum-Based Measures* (EN-CBM; Clarke & Shinn, 2004)

Observation Measure

- *Classroom Observations of Student-Teacher Interactions-Mathematics* (COSTI-M)
  - Trained observers used the COSTI-M to document the real-time occurrences of (a) student practice opportunities and (b) teacher demonstrations and explanations
  - ELM and control classrooms were observed up 3x (fall, winter, and spring)

Analysis

- Latent difference score model (Raykov, 1992). The model measured (a) a latent difference score representing logged individual student pracitce opportunities minus logged teacher demonstrations, and (b) a latent intercept score representing latent logged teacher demonstrations.

RESULTS

- Our model fit well
  - Chi-square = 32.98, *df* = 32, *p* = .419, RMSEA = 0.003, CFI = 0.987, TLI = 0.986.
- Within the ELM dataset, we did not find threshold effect of individual practice opportunities
- However, the linear effects analysis was positive and strongly significant, indicating that a higher number of individual practice opportunities for each teacher demonstration flattened the random slope.
- Flattening slope is evidence of differential effectiveness benefiting students with MD
  - Using model parameters from Table 2, we computed the difference in student gains on the TEMA-3 in a classroom that facilitated three individual practice opportunities to every teacher demonstration (i.e., 1:3 ratio) and compared to a classroom that provided a dosage of one practice for every teacher demonstration (i.e., 1:1 ratio).
  - The difference in gains for pretest scores of 57, 64, 68 and 75 are, respectively, 9.4, 8.4, 7.9 and 7.0 raw points on the TEMA-3
  - Given the normative *SD* of 15 (compared to a sample *SD* of 17), these result in Hedges' *g* effect sizes of .63, .56, .53 and .47

CONCLUSIONS

- Given the beneficial effects of facilitating three individual practice opportunities for every teacher demonstration, a recommendation is that teachers provide this dosage when delivering core mathematics instruction that includes students with MD.
- Unable to examine higher dosages of student practice opportunities because three was the upper limit of the ELM dataset
  - Functional plateau of practice likely exists because students, particularly students with MD, require explicit demonstrations to know what and how to practice
  - Future research should investigate for possible threshold effects of practice
- Identifying optimal dosages of student practice has implications for the instructional design of mathematics programs and the professional development opportunities teachers who work with students with MD receive during the school year.

DESCRIPTIVE STATISTICS

Variable	Occasion	N	M	SD	Skew	Kurt
Student-level variables						
LEP status		2,650	0.29	0.45	0.93	-1.13
EN-CBM pretest		2,337	75.58	51.79	0.62	-0.28
TEMA-3 pretest		2,212	90.29	17.06	0.17	-0.28
TEMA-3 posttest		2,383	101.41	14.73	-0.11	0.16
Teacher-level variables						
Individual practice-teacher demonstration ratio	Observation 3	128	1.24	0.75	1.55	3.36
	Observation 2	127	1.12	0.91	1.69	2.93
	Observation 1	59	-0.06	0.61	-0.47	-0.27

TWO-LEVEL INTERACTION MODELS

Effect	Variable 1	Variable 2	Est.	S.E.	p
Student level					
Regressions	TEMA-3 posttest ON	LEP status	-0.074	0.033	0.024
	EN-CBM pretest ON	LEP status	-0.192	0.033	0
		TEMA-3 pretest	0.954	0.016	0
Covariance	EN-CBM pretest WITH	TEMA-3 posttest	0.037	0.005	0
Means	TEMA-3 pretest		-1.919	0.043	0
Intercepts	EN-CBM pretest		1.859	0.033	0
Variances	TEMA-3 pretest		0.751	0.028	0
Residual	TEMA-3 posttest		0.162	0.007	0
Variances	EN-CBM pretest		0.245	0.011	0
Classroom level					
Regressions	Random slope ON	Demonstration rate	-0.037	0.098	0.703
		Latent difference	-0.162	0.044	0
		Texas	0.016	0.044	0.709
		Private	-0.017	0.039	0.672
		TEMA-3 pretest class average	0.004	0.002	0.072
	Demonstration rate ON	Texas	-0.282	0.071	0
	Demonstration rate ON	Private	-0.199	0.085	0.02
	Demonstration rate ON	TEMA-3 pretest class average	0.006	0.004	0.139
	Latent difference ON	Texas	0.147	0.103	0.154
		Private	0.323	0.12	0.007
		TEMA-3 pretest class average	-0.004	0.006	0.539
	TEMA-3 posttest ON	Texas	0.191	0.071	0.007
		Private	0.035	0.049	0.472
		TEMA-3 pretest class average	0.012	0.004	0.003
Covariance	Difference WITH	Demonstration rate	-0.022	0.017	0.2
Intercepts	TEMA-3 posttest		6.186	0.036	0
	Individual practice rate		-0.334	0.053	0
	Demonstrate rate		-0.201	0.04	0
	Random slope		0.628	0.02	0
Residual variances	Individual practice 1-3		0.151	0.018	0
	Demonstrations 1-3		0.165	0.019	0
	Difference		0.101	0.028	0
	Demonstration rate		0.038	0.018	0.035
	Random slope		0.005	0.001	0

ACKNOWLEDGEMENTS

Funding Acknowledgement: The research reported here was supported by Institute of Education Sciences, National Center on Educational Research, through Grant R305A150037 to the Center on Teaching and Learning at the University of Oregon

Manuscript Acknowledgement: Doabler, C.T., Baker, S., Stoolmiller, M., Gearin, B., Kennedy, P., Clarke, B., Nelson, N. J., Fien, H., Smolkowski, K. (submitted for publication). *Investigating dosages of practice in the context of explicit mathematics instruction*

The University of Texas at Austin Special Education College of Education · CTL Center on Teaching & Learning · ies National Center for Education Research, Institute of Education Sciences