Implementing Mathematics Learning Software Successfully in Urban Schools

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Abstract

We present findings and lessons learned from implementing and scaling up a research-based mathematics learning technology intervention in 41 classrooms in urban schools serving predominantly low-income students. We address issues essential to improving educational equity, diversity, and student achievement by examining the circumstances and resource configurations that enabled or impeded implementation of the innovative learning software. This analysis is part of a larger federally funded RCT testing 4 web-based Perceptual Learning Modules (PLMs) focused on key concepts related to fractions and measurement that were developed through an extensive research process. PLMs were implemented in successive years with two cohorts of sixth-graders. This analysis summarizes quantitative and qualitative data examining challenges and factors associated with (1) the quality of implementation across participating teachers and schools, and (2) retention and attrition of schools and teachers across the two-year duration of the study.

Perceptual Learning Intervention

The intervention consisted of 4 Perceptual Learning Modules (PLMs) designed to improve students' ability to recognize and work with key structures and relations defining fundamental concepts related to fractions and units of linear and area measurement.

An example of one module is shown in Fig. 1. The Slice & Clone 1 PLM makes the relational structure that defines fraction concepts tangible to learners by providing them with interactive on-screen tools that they can manipulate. Partitioning a continuous quantity creates a unit fraction that can be iterated to create new quantities. Students work with proper and improper fractions, mixed numbers, and integers to extract unit fractions and to create new quantities in every format.

Method & Sample

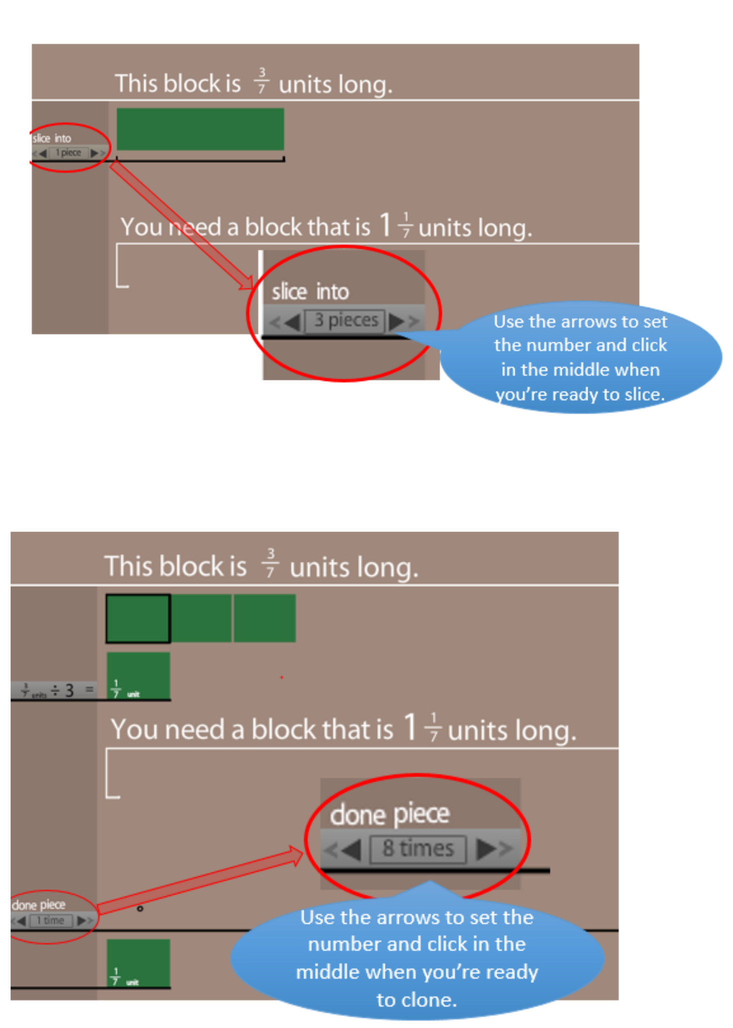
Students completed PLMs over the course of the school year, working with each PLM for approximately 20-30 minutes several times per week for 3-4 weeks. The software adapted to each student's individual performance by retiring subcategories as he or she demonstrated mastery across each type of item. PLMs were completed when all subcategories were retired. Success of implementation is measured here as the mean percentage of each PLM that was mastered, averaged across PLMs and students within a class.

Table 1: Sample characteristics by cohort and correlation with average classroom mastery levels.

	Cohort 1			Cohort 2		
	Mean	Rho	P	Mean	Rho	P
% Minority	0.65	-0.54	**0.005**	0.62	-0.39	**0.052**
% Free or Reduced-price Lunch	0.66	-0.23	0.260	0.65	-0.50	**0.010**
% Disability	0.10	-0.24	0.246	0.11	-0.27	0.190
% Limited English Proficiency	0.10	0.07	0.737	0.10	0.21	0.305
Math (centered scaled score)	-0.07	0.38	**0.053**	-0.06	0.34	0.088
Reading (centered scaled score)	-0.05	0.43	**0.029**	-0.05	0.39	**0.040**

Example PLM Item

Figure 1: Slice & Clone 1 PLM



Students start with a given quantity and use the slicing and cloning tools to create a new quantity. As shown in the top panel, students use a "slicer" tool to cut a continuous extent into a desired number of pieces, thus creating a unit fraction. As shown in the bottom panel, when they have created a successful unit, it drops down into a "cloner" that will iterate that unit a desired number of times and output the result. While these screenshots are static, the actual PLM is fully interactive with response-specific, animated feedback at each step.

What predicts retention or attrition from the study?

	Early Attrition within Cohort	Late Attrition within Cohort	Attrition between Cohorts	Partial or Delayed Implementation	Total
Rostering and re-rostering issues (shortened periods, classes shuffled, classes eliminated)	10	1	2	2	15
Change to teacher's position (laid off, quit, changed grade or subject)	4	1	4	0	9
Medical and maternity leaves or absences	0	0	0	6	6
Technology infrastructure or access	4	1	0	1	5
Competing priorities and demands, unstable support from school leadership	3	2	0	1	6

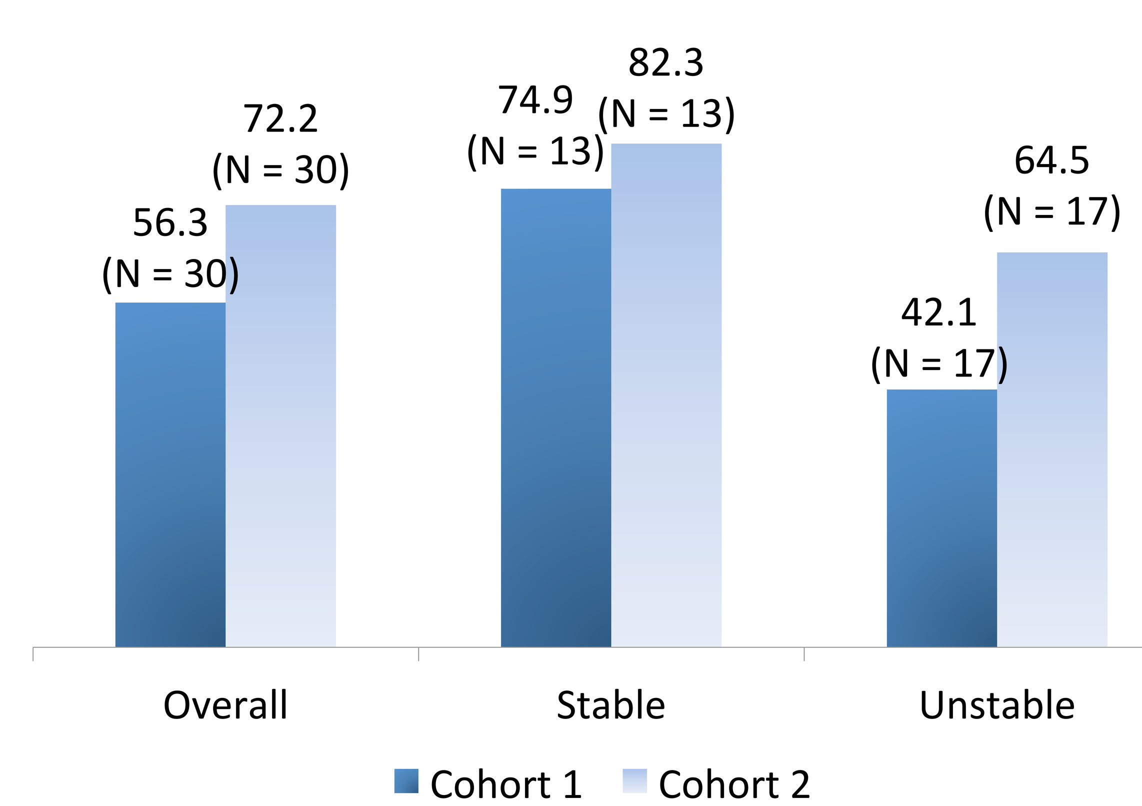
18 schools and 18 teachers continued across cohorts. Attrition was mostly attributable to instability in leadership, teacher assignments, and roster schedules. Technology barriers were largely able to be ameliorated using project resources. Only 1 teacher chose to discontinue participation in the absence of other barriers.

What resources were needed?

- ✓ Teacher professional development
- ✓ Supplemental laptops (up to 15 per class)
- ✓ On-site technical & logistical support
- ✓ Teacher dashboard with real-time data & easily accessible resources
- ✓ Regularly updated planning documents
- ✓ Target usage benchmarks based on prior data

What predicts degree of students' mastery of the intervention?

Figure 2: Average level of mastery achieved by students in Stable vs. Not Stable classrooms.



Cohort 1: % Mastery ranged from 13-99%
Cohort 2: % Mastery ranged from 69-99%

All teachers in Stable classes and schools continued from Cohort 1 to 2.
The Unstable category in Cohort 2 included 5 continuing teachers plus 12 new teachers, all of whom had unstable situations.

Both cohorts had some high-mastery classes but Cohort 1 had more classes with low mastery levels. Classrooms of both new and continuing teachers achieved higher levels of mastery on average in Cohort 2, with most gains coming from raising levels in lower-performing, less stable classes. Minority status was negatively correlated with mastery levels in both Cohorts. Students' prior year standardized Math scores predicted mastery levels in Cohort 1 but not Cohort 2, while Reading scores were correlated for both Cohorts.

Conclusions

- Attrition was mostly driven by instability in school leadership, teacher assignments, and roster schedules. Instability (or "churn") compromises adoption of new practices as well as capacity to conduct studies with important target populations.
- Multiple types of support provided by the project enabled participation by challenged schools.
- Approximately half of the classes would have had difficultly implementing individual learning software without supplemental computers and tech support.
- Professional development, usage benchmarks appropriate for the student population, a consistent but flexible planning process, and online teacher-friendly resources helped teachers implement successfully with a broad spectrum of students.

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