Elementary-Grade Math Programs in the Pittsburgh Public Schools: A Comparison of Everyday Mathematics and Harcourt Math

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INTRODUCTION

Like many urban school districts, the Pittsburgh Public Schools (PPS) are facing challenges in raising the achievement levels of their students. In elementary-grade math, 36 percent of Pittsburgh's students failed to achieve proficiency in 2006. As in other urban districts, there is a substantial achievement gap between white students and African American students in the PPS. Nearly half of Pittsburgh's African American students in elementary grades fell short of proficiency in math in 2006, while only one-fifth of white elementary students fell short.

Under the leadership of Superintendent Mark Roosevelt, in 2006 the district launched an ambitious initiative to achieve "Excellence for All." The Excellence for All initiative has set specific district-wide targets for improvements in achievement, with especially aggressive targets for African American students, in the hope that the racial gap in achievement can be substantially reduced and ultimately eliminated. Excellence for All intends to produce achievement improvements in all grades and subjects. In the elementary grades, efforts in the first year of the initiative focused on reading. PPS is now turning its attention to elementary grade math, with district-wide curriculum decisions expected in the coming months. This report is intended to inform the PPS decision-making process, by providing a comparative evaluation of the two elementary mathematics programs that have been operating side by side in the district since 2005.

In the fall of 2005, PPS began a pilot test of *Harcourt Math* (referred to hereinafter as Harcourt), published by Harcourt School Publishers, in grades K through 5 in nine schools.[1] The rest of the district's elementary schools have continued to use *Everyday Mathematics* (EDM),

[1] The Harcourt pilot schools were Crescent, Faison, Lincoln, Manchester, Morrow, Northview, Roosevelt, Sunnyside, and West Liberty. Crescent Elementary was one of 22 schools that were closed as part of PPS' "right-sizing" plan in 2006, but the other eight schools have now completed two years of the pilot.

published by Wright Group/McGraw Hill, the program that had been in place district-wide since the 1990s. The initiation of the pilot was motivated in part by a perception among some PPS educators that the Harcourt program might be better suited to serving students who are struggling in math, many of whom are African American.

This report presents findings from an analysis that compares the impact of the Harcourt and Everyday Mathematics programs on the achievement of participating students, including policy-relevant subgroups such as African American students, low-achieving students, low-income students, and girls. It also presents findings from a qualitative examination of the characteristics of the two curricula and on how they have been implemented in Pittsburgh schools.

In brief, we find no evidence that either program produces stronger achievement results, overall or for any of the examined subgroups. The lack of achievement differences may be partly related to the fact that achievement trajectories can thus far only be compared for two years. The lack of achievement differences may also be related to one of our key implementation findings: teachers are liberally supplementing both programs—in some cases with materials from the other program—making the two programs less different in practice than in theory. Indeed, some of the teachers we interviewed wanted the district to provide more guidance about supplementation, so that whatever program materials were in use could become part of a more-comprehensive and complete curriculum.

The first section of the report provides a description of the programs, based on a review of existing literature and interviews with PPS staff. The second section presents the achievement analysis and results, and the third section discusses findings on implementation of the two programs based on interviews in a sample of schools.

THE PROGRAMS: *HARCOURT MATH* AND *EVERYDAY MATHEMATICS*

Our review of the literature made it clear that EDM and Harcourt are grounded in different design assumptions. EDM is university-developed and has a reform orientation rooted in the standards of the National Council of Teachers of Mathematics (NCTM) (1989). It was produced with funding from the and National Science Foundation (NSF) designed to enable developers to translate those standards into full-blown classroom mathematics programs. At the heart of that reform orientation is an inquiry approach to mathematics, in which students are expected to develop mathematical thinking through the exploration and application of mathematical principles rather than through direct instruction (Carroll 1998; Isaacs 2001). Harcourt is a commercially developed program with a more traditional design and instructional approach. As compared to EDM, the Harcourt program relies much more on direct, whole-class instruction in which the teacher models a strategy that students then practice. Most of the practice for skills mastery comes in the form of worksheets completed by individual students, as opposed to the games and group projects used heavily in EDM, so the Harcourt program more closely resembles math instruction as most parents remember it from their own classroom experiences.

The table below summarizes some of the key design differences between the two programs. Although this table is drawn from our review of the literature, these distinctions were strongly reinforced in our interviews with users of the two programs in PPS and were important factors in shaping their implementation of the curricula. Following the table we provide more detail on how the programs compare on the highlighted dimensions.

TABLE 1

THE DESIGN OF EVERYDAY MATHEMATICS AND HARCOURT MATH

	Everyday Mathematics	Harcourt Math
Sequencing	Spiral/integrated *Skills secured through exposure over time*	Linear/self-contained *Skills taught to mastery before moving on*
Source→ Development of Math Ideas	Inquiry/exploration→ application	Instruction→ practice
Procedures	Multiple paths, explored and discovered by students	Single path, modeled by teacher and copied by students
Mode of Instruction	Teacher-supported small group work	Teacher-led whole class instruction
Skills Practice	Games/routines	Worksheets

Sequencing

As the table shows, the programs are sequenced in different ways. EDM is designed as a "spiral" or integrated math program, meaning that students are not expected to understand a concept or skill fully the first time they encounter it. Instead, students master mathematical concepts and skills through multiple exposures over the course of two years or more without the pressure of mastering every skill when it is first presented to them (Braams 2003). Lessons are designed to build upon previous lessons across students' current grade level, as well as prior grade levels. Harcourt, on the other hand, provides a "linear" or self-contained program, in that each skill (for example, addition, subtraction, or fractions) is taught to mastery before the students move on to another skill. In the Harcourt materials, skills are reviewed occasionally, but not to the extent that they are developed over time in the EDM program.

Source and Development of Mathematics Ideas

Teachers and students approach mathematics learning in very different ways through the two programs. In EDM lessons, students are expected to engage in inquiry and exploration with mathematics concepts and uncover the full meaning of those concepts by applying skills in concrete, hands-on activities (Carroll, 1998). In contrast, with Harcourt, students receive instruction and modeling from the teacher for mathematics problems, and then they practice those problems independently, following the teachers' directives.

Procedures and Mode of Instruction

During their exploration, students using EDM are encouraged to come up with their own strategies and ideas for solving problems. Thus, multiple problem-solving strategies might be discussed by students and the teacher within one EDM lesson (Isaacs 2001). Students often do this problem-solving work in small groups or pairs, with the teacher facilitating and supporting students' work. The teacher is then expected to use students' strategies as a centerpiece for whole-class discussion that will move students toward the mathematical objectives for the lesson. By contrast, Harcourt lessons offer a more traditional format, in which the teacher provides whole-class instruction about one efficient strategy for solving a particular kind of mathematics problem. The students are then expected to copy the path modeled by the teacher in their practice. While the texts may occasionally introduce more than one strategy for solving problems, Harcourt materials reflect the assumption is that there is usually one best way to solve mathematical problems and that way should be provided to students when those problems are introduced in the classroom.

Skills Practice

While some detractors of EDM complain that the program does not provide enough traditional skills instruction (Clopton, McKeown et al. 1999a; Clopton, McKeown et al. 1999b; Klein 2000), skills instruction and practice in EDM are provided by games and everyday routines such as using a calendar, tracking attendance, or talking about temperature (Bell et al, 2004). In Harcourt materials, skills practice is offered in a more traditional worksheet format, with many problems of one type on a page for students to answer in order to practice the skill.

ACHIEVEMENT ANALYSIS

The main research questions for the impact analysis are: (1) How do the Harcourt and EDM programs compare in raising the achievement of students in participating schools? and (2) Is one or the other program producing greater achievement gains for African American students, thereby helping to reduce the racial gap in achievement? Related questions involve effects on achievement for low-income students, students with high and low levels of baseline achievement, girls, and students who switch between the two programs as a result of changing schools.

Methods and Data

We use longitudinal, student-level data for three cohorts of PPS elementary school students to assess differences in achievement gains for students in schools that use the Harcourt math program and those that use the EDM program, over the course of the first two years that Harcourt was implemented (2005 through 2007) in a subset of PPS elementary schools. The achievement analysis includes the three cohorts of students for which we can potentially observe students in tested grades of elementary school for at least three years. These three cohorts include students in grades 1 to 3 in 2004 to 2005, who advanced to grades 3 to 5 two years later, in 2006 to 2007. Table 2 illustrates the three student cohorts, with math and reading scores on the Pennsylvania System of School Assessment (PSSA) used for grades 3- to 5 and on the Terra Nova used for grades 1 and 2. In order to compare test scores for individual students over time, we convert all test scores into standardized measures that put scores across different grades and tests on the same metric.[2]

TABLE 2

COHORTS INCLUDED IN ACHIEVEMENT ANALYSIS

	2003-04[3]	2004-05	2005-06	2006-07
Grade 5	-	-	-	PSSA
Grade 4	-	-	PSSA	PSSA
Grade 3	-	PSSA	PSSA	PSSA
Grade 2	Terra Nova	Terra Nova	Terra Nova	-
Grade 1	Terra Nova	Terra Nova	-	-

The number of schools and students using EDM in Pittsburgh is much larger than the number using Harcourt, which is being used in eight elementary schools on a pilot basis. In order to ensure that the comparison group of students in EDM schools has similar observable characteristics to the Harcourt group, we created a matched sample of EDM students using propensity score matching. In essence, propensity score matching examines the student characteristics that predict whether a student is in a Harcourt school, and then uses these

[2] We convert the test scores into rank-based Z-scores, which are similar to Normal Curve Equivalent (NCE) scores, in that they fit the scores into a normal distribution by grade, subject and year. The difference is that NCE scores are typically reported on a scale of 1 to 99 with a mean of 50, whereas rank-based Z-scores have a mean of zero and a standard deviation of one for each grade and subject. While this does not yield a psychometrically valid developmental scale, it does allow for comparisons of scores across grades and years. See the appendices of Gill et al (2005) for more details.

[3] For two of the three cohorts we have 2003-2004 test scores, which we use to measure student test score trajectories prior to the Harcourt pilot period.

characteristics to identify a similar sample of EDM students.[4] This technique matches students based on their math scores in 2004-2005, immediately prior to the initiation of the Harcourt pilot, as well as on other student characteristics such as gender, race/ethnicity, free or reduced-price lunch eligibility, and IEP status.[5] Each student that we observed at a Harcourt school in either 2005-2006 or 2006-2007 is matched with a student that we observed at an EDM school in both 2005-2006 and 2006-2007.[6]

Table 3 compares the average characteristics for students in Harcourt schools and EDM schools, as well as for the comparison EDM sample. The table includes students in grades 3 to 5 for 2006-2007 (the cohorts included in the achievement analysis). Students at Harcourt schools are more likely to be African American and low-income than students in EDM schools, and also have lower average 2004-2005 math scores than students in EDM schools. The matched sample of EDM students, however, closely resembles the Harcourt group in terms of both demographics and initial achievement levels, with all differences statistically insignificant.

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[4] For an overview of propensity score matching see Cook, Campbell, and Shadish (2001). Constantine et al (2006) use propensity score matching to examine educational outcomes across several states.

[5] The propensity score is generated as the predicted value from a logit regression with one observation per student, where the dependent variable is an indicator for the student attending a Harcourt school in either 2005-2006 or 2006-2007, and the explanatory variables are the student's standardized 2004-2005 math score, indicators for student gender, race/ethnicity, IEP status, free or reduced-price lunch status, and limited English proficiency status, as well as cohort indicators. Each Harcourt student is matched to a comparison EDM student using nearest-neighbor propensity score matching.

[6] Only students with non-missing test scores in 2004-2005, 2005-2006, and 2006-2007 are included in the matched sample analysis.

TABLE 3

AVERAGE STUDENT CHARACTERISTICS, 2006-2007

		Everyday Mathematics	
Student Characteristics	Harcourt	Matched Sample[7]	All Students
Female	47.3%	47.1%	49.2%
White	27.6%	25.5%	38.0%
African American	67.3%	70.1%	53.4%
IEP	16.8%	17.1%	16.6%
Low-income	83.1%	82.5%	72.6%
Standardized Math Score	-.122	-.090	.057
Standardized Reading Score	-.151	-.103	.060
2004-2005 Math Score	-.091	-.099	.080
Number of Students	1,145	1,346	4,431

We use a quasi-experimental "difference-in-differences" analysis to compare the achievement of students before and after they participate in the Harcourt program, relative to the change in achievement of a matched comparison group of students in EDM schools elsewhere in the district. The quasi-experimental design does not necessarily provide causal inferences with the same validity as those from a randomized experiment, but it uses the best nonexperimental methods possible.[8]

The difference-in-differences design compares achievement trajectories for Harcourt and EDM students, with the temporal structure of the data as follows:

[7] Matching was conducted based on 2004-2005 characteristics. Some of the students in the Harcourt treatment group for the matching analysis attend Harcourt schools in 2005-2006 but switched to an EDM school in 2006-2007, which is why the matched sample has more EDM students than Harcourt students in 2006-2007.

[8] The ideal design would be a randomized experiment in which students or schools were assigned to the two programs by lottery, but such an experiment cannot be assigned retrospectively.

	Time	
Harcourt students	O_1 X O_2 O_3	
	---------------------	(where O_1, O_2, and O_3 are annual observations
EDM students	O_1 O_2 O_3	and X is the initiation of Harcourt treatment)

The diagram represents a simplified version of the actual data structures, as students in some cohorts will have more than one score prior to treatment. By examining changes in achievement for the same students over time, we can control for individual student characteristics that may otherwise affect achievement, as long as those characteristics are constant over time, a method called a student fixed-effects analysis.[9]

Because there are only two years of achievement data for the Harcourt pilot, and because PPS now conducts end-of-year standardized math assessments only beginning in grade 3, it is important to recognize that virtually all of the Harcourt students included in the analysis had exposure to EDM when they were younger. The students who began with Harcourt in kindergarten in fall 2005 were only completing first grade in spring 2007, and no test scores are available for them. The students included in the analysis were in grades 3 to 5 in spring 2007, and therefore had completed first grade, second grade, or third grade in EDM before the Harcourt pilot was initiated. It will not be possible to examine state test results for a cohort of students who were educated entirely with Harcourt until after spring 2009 PSSA results for third-graders become available. In consequence, readers should keep in mind that, for now, the

[9] See Wooldridge (2002) for an overview of fixed-effects models, and Sass (2006) for application examining charter schools in Florida. Gill, Engberg, and Booker (2005) used this approach as one component of their assessment of school performance in Pittsburgh.

comparison of the two programs is really a comparison of students who used EDM in all grades to students who started in EDM and switched to Harcourt.

Strategy for Assessing Validity

Although our primary achievement measure is student math scores, we also conduct a parallel analysis of the effect of participating in one or the other math program on reading achievement. We would not expect the choice of math program to be associated with differential changes in reading achievement. If we find a relationship between reading achievement and the math programs, it would suggest that there is something else associated with attending a school using a particular math program that is confounded with, but unrelated to, the math program itself. If, in contrast, we observe effects on math achievement but not on reading achievement, we will have more confidence in attributing those effects to the math program. In short, examining reading outcomes alongside math outcomes helps to provide confidence in our interpretation of any observed math effects: Math impacts without reading impacts suggest a real effect of the math program, while reading impacts observed alongside math impacts suggest that something else in the schools is the real cause.

Achievement Impact Results

The primary estimation equation for the analysis is:

(1) $A_{i,t} = \beta_1 * H_{i,t} + \beta_2 * X_{i,t} + \beta_3 * Y_{y,t} + \theta_{g,t} + \mu_i + \varepsilon_{i,t}$

where A is student achievement level, H is an indicator for attending a Harcourt school, X is a vector of time-varying student characteristics, Y is a vector of school characteristics, θ is a vector of grade-by-year indicators, and μ is a vector of individual student indicators.[10] We adjust the standard errors for the clustering of students within schools.[11]

In addition to the overall math program effect, we estimate models interacting the math program indicator with different student characteristics, to explore the possibility of differential effects. These characteristics include:

- African American students
- Girls
- Low-income students (as measured by free or reduced-price lunch eligibility)
- Students in their first year in a Harcourt school versus those in their second year
- Students with low baseline levels of achievement versus those with high baseline levels of achievement (as measured by spring 2005 math scores)

Table 4 reports the results of the analyses. The indicator used in the equation involves attending a Harcourt school, so positive results favor the Harcourt program while negative results favor EDM. We find that the estimated math program effect is not significantly different from zero for any of the specifications, either overall or interacted with student characteristics. The estimated reading effects (not reported here) are also all insignificant.

[10] The student characteristics include IEP status, free or reduced-price lunch status, limited English proficiency, and whether the student switched schools since the previous year. The school characteristics include being an Accelerated Learning Academy, the percentage of students at the school who switched schools since the previous year, and the percentages of students who are African American, Hispanic, eligible for free or reduced-price lunch, IEP, and limited English proficient.

[11] We use the cluster option in Stata, which adjusts the estimated variance under the assumption that observations are independent across schools but not within schools. See Rogers (1993) for more detail.

TABLE 4

ACHIEVEMENT EFFECTS OF HARCOURT MATH VERSUS EVERYDAY MATHEMATICS,
LEVELS SPECIFICATION

	Math (z-score)
Harcourt school (H) (overall effect)	.005
H * First year in Harcourt	.016
H * Second year in Harcourt	-.020
H * Low-income	-.002
H * African American	-.011
H * Female	-.009
H * Lowest 2004-2005 math quartile	.060
H * Middle two 2004-2005 quartiles	.006
H * Highest 2004-2005 quartile	-.050

^ indicates significance at 5% level

The standard error on the overall math program coefficient is approximately .05, which corresponds to a minimum detectable effect of one-tenth of a standard deviation in test score levels. Thus, the analysis has sufficient statistical power to detect relatively small achievement impacts, and the absence of statistically significant effects cannot be attributed to insufficient statistical power. For the subgroup interactions, the minimum detectable effect is somewhat larger, but is still generally less than .15 standard deviations.

As a sensitivity test, we also estimated an alternative model specification, with student test score gains as the dependent variable, rather than test score levels. This can be thought of as a "differences-in-differences-in-differences" specification, where the math program effect is identified based on changes in the rate of student test score *growth* before and after entering treatment status. Table 5 reports the estimated math program effects from this analysis, for the propensity-matched sample. The results are essentially the same: None of the differences achieve statistical significance in favor of Harcourt or EDM. In the gains specification, all of the point estimates slightly favor EDM over Harcourt (as indicated by the negative signs), but the absence of statistical significance should caution against reading too much into these results. The estimated reading effects (not reported here) are also all insignificant.[12]

TABLE 5

ACHIEVEMENT EFFECTS OF HARCOURT MATH VERSUS EVERYDAY MATHEMATICS,
GAINS SPECIFICATION

	Math (z-score)
Harcourt school (H) (overall effect)	-.031
H * First year in Harcourt	-.024
H * Second year in Harcourt	-.056
H * Low-income	-.051
H * African American	-.073
H * Female	-.051
H * Lowest 2004-2005 math quartile	-.016
H * Middle two 2004-2005 quartiles	-.040
H * Highest 2004-2005 quartile	-.025

^ indicates significance at 5% level

As we describe in the implementation section that follows, the absence of an achievement advantage for one program or the other may be partly attributable to the fact that the two programs are less different in practice than in theory, given the supplementation that is occurring in both programs. In addition, it is important to keep in mind that it is possible at this date to compare the two programs over only two years of treatment.

[12] As an additional sensitivity test we ran both specifications for the full sample of EDM students, rather than just the propensity-matched comparison group, with essentially identical results.

Effects on Students Who Switch Programs

Another important policy question is whether there is any negative effect associated with a student switching from one math program to another. The closing of 22 PPS schools between 2005-2006 and 2006-2007 allows us to test for these effects, as it caused many students to switch schools. Some students moved to schools with the same math program used in their previous school, while others were assigned to schools with a different math program. Examining these two subgroups enables us to distinguish the effect of switching schools from the effect of switching programs. We examined test scores for students who switched schools between 2005-2006 and 2006-2007, testing for differential gains between those who switched from Harcourt to EDM or from EDM to Harcourt as compared to those who switched schools but remained in the same math program. There was no evidence that switching programs had any negative effects on students, regardless of whether they switched to Harcourt or to EDM. This effect could be measured only in the first year after switching; it is possible that effects would become apparent in later years after a switch.

IMPLEMENTATION OF EDM AND HARCOURT

The remaining sections of this paper present findings on differences in the classroom implementation of the two programs as experienced by PPS teachers and instructional coaches. The most significant finding is that the two programs as implemented are less different than they may appear to be on paper. This is primarily because teachers using both programs reported extensive supplementation to fill perceived gaps and weaknesses of whichever program they were expected to implement. Specifically, because EDM is seen by many teachers as weak on skills practice, EDM teachers often build skills practice into their curriculum, pulling from a variety of resources. Because Harcourt is seen as “dry” and less engaging for students and as offering insufficient challenge and opportunities for mathematical thinking, many Harcourt teachers supplement to add those kinds of experiences for their students. Because most teachers now using Harcourt have been trained in EDM, many are drawing games and routines directly from EDM. Thus, while the charts and accompanying text below draw a rather stark contrast between the two programs, in most classrooms teachers are searching for a middle way that combines what they see as the strengths of both programs. We conclude by suggesting that the consistent patterns of supplementation reported in our sample suggest the desire of many PPS teachers for a more balanced approach.

Implementation Analysis Methods

To enrich our interpretation of the achievement analysis and inform the district's decision-making process, we supplemented the quantitative component of the study with qualitative research in a sample of PPS elementary schools currently using each of the programs. We began by conducting a literature review on the design, implementation history, and student achievement impacts of the two programs. We also conducted background interviews with past and present PPS central office personnel in order to shape our understanding of the district's history and current direction in elementary mathematics. Our school-level research questions focused on the characteristics of the two programs as experienced by users and on the experience of implementing each one in the classroom. Specific topics included how each program addressed the following:

- Coverage of core math skills
- Development of mathematical thinking and problem-solving skills
- Quality and utility of the materials and associated assessments
- Alignment with state standards and tests

- Meeting the needs of all students
- Ability of parents to support their students in math

Interviews were conducted in October 2007 in eight randomly chosen PPS elementary schools, four using Harcourt and four using EDM. Two of the four EDM schools were part of this year's pilot of EDM3, the newest version of the Everyday Mathematics program. At each selected school, we conducted four 45-minute structured interviews, three with teachers and one with the curriculum coach responsible for supporting teachers in mathematics. Teachers were randomly selected from grades 1, 3, and 5. In the Harcourt schools, where almost all teachers would have had experience teaching with both programs, we pressed for direct comparisons between the two programs on each critical domain.

Prior Implementation Literature

The design differences between these mathematics programs imply that teachers will not implement the programs in the same way. While most research on math programs focuses upon student achievement rather than teachers' use of program materials, Stein and Kim (in press) have undertaken a rare analysis of how the EDM materials facilitate instruction. They note that while EDM lessons emphasize meaningful connections between mathematics procedures and larger math concepts, the materials may not provide teachers with enough information about the objectives of each lesson and how students might work through problems in the lessons. Thus, according to Stein and Kim, the message within EDM materials is that teachers should stick to the letter of the program rather than rely on their own knowledge and resources because "a relatively complete image of practice is captured in the curricular material and… the closer students stay to the prescribed actions, the more successful the lesson will be" (p. 26). Additionally, Stein and Kim note that EDM's "spiraling" curriculum places high "social capital" demands upon teachers who must trust that those at different grade levels will carefully follow EDM's instructional trajectory so that students will fully master math concepts.

Stein and Kim's observation that the EDM program is designed to be followed closely by teachers across grades is echoed in further preliminary research from Stein et al.(2007), noting that teachers who maintain the "cognitive demand" within the program materials are those who implement EDM faithfully. However, faithful implementation of EDM across all grades may be difficult. In their study of EDM's implementation and impact at PPS (including achievement analyses that will be discussed in the next section of this report), Briars and Resnick (2000) noted high variability in EDM's implementation among teachers and schools across PPS, which they attributed to a "pervasive culture of teacher independence" in Pittsburgh; a lack of content knowledge among teachers; and pressure from parents for a more traditional program of instruction (pp. 27-28).

In contrast to EDM, no work has been done to evaluate the implementation of Harcourt, which is a commercially produced program. In fact, in Confrey et al's (2004) exhaustive review of curriculum evaluations, they only located one content analysis of *Harcourt Math Advantage* (a predecessor of *Harcourt Math*) compared to the 51 studies of EDM.[13] Confrey et al. surmise that such a dearth of studies exists for Harcourt and other "commercial" programs compared to NSF-funded curricula such as EDM because those NSF-funded projects are often required to supply evaluations of their use and because commercial publishers most often provide market studies that are "only marginally useful in evaluating curricular effectiveness" (p. 28).

[13] The literature search conducted by Confrey et al. (2004) included requests to publishers; requests on mathematics and mathematics teaching listservs; and library and web searches.

Relative Strengths and Weaknesses of Each Math Program According to PPS Staff

In this section, we explore the relative strengths and weaknesses of each program, as described by PPS teachers and curriculum coaches. We examine these strengths in three separate domains: how each program develops mathematical knowledge; how each program meets the needs of all students (including high- and low-performing students); and how each program is used in schools across the district. As will be seen in the analysis below, descriptions from PPS staff about the strengths of one program more or less mirror the weaknesses of the other program, which further emphasizes the differences described in the prior section on program design and implementation.

Developing Mathematical Knowledge

Table 6 presents the strengths of each program in terms of developing mathematical knowledge in key areas, as described by PPS teachers and coaches.

TABLE 6

HOW EACH PROGRAM DEVELOPS MATHEMATICAL KNOWLEDGE- RELATIVE STRENGTHS REPORTED BY PPS STAFF

	Everyday Mathematics	Harcourt Math
Resources for skills practice		X
Skills mastered before moving on		X
Number sense	X	
Conceptual understanding	X	
Opportunities to apply skills	X	
Problem solving	X	
Exploration of multiple approaches	X	
Rigor	X	

Many teachers talked about the ample skills practice provided in the Harcourt materials. Harcourt provides skills practice through numerous workbooks designed to meet the needs of students at different levels: a "challenge" workbook, a "reteaching" workbook, and so on. Each of these workbooks contains sample problems and multiple practice problems that help students learn basic skills. While some teachers appreciated the presence of so many practice problems, one fifth grade teacher said, "If a teacher isn't careful, I could see how Harcourt could degenerate into drill and skill because lots of practice is available." For EDM, on the other hand, teachers sometimes worried that students are not mastering basic skills because the program does not provide as much practice. However, several teachers and coaches also emphasized that students get practice through the games and routines in EDM, even though some teachers don't perceive those games and routines as practice because they are not the traditional worksheet practice with which teachers are most familiar.

Teachers also appreciated Harcourt's linear structure, which allows students to master skills before moving on. However, teachers expressed concern that Harcourt does not come back to skills which have already been addressed. Instead, those skills are taught in a "big block," assumed to be mastered, and not reviewed extensively later on. In contrast, teachers liked EDM's review and “mixed practice” sections, which continually pick up upon developing skills, but they complained that EDM's spiral structure does not provide enough depth in the skills that it addresses within each lesson. EDM teachers also talked about the spiral structure of the program being confusing or frustrating students who do not know or understand why they are not mastering all the material presented in lessons and assessments.

While some teachers wished for more skills practice in the EDM materials, they praised the program's emphasis on conceptual understanding and problem solving, as well as the continual opportunities for students to apply skills through hands-on activities. Additionally, teachers talked about how students' exploration of multiple approaches to solving problems allowed them to further deepen their understanding about mathematics. In Harcourt materials, teachers said that students do not talk about "why" they are using the strategies to solve problems that are recommended in the text, and students thus do not develop as comprehensive an understanding about the concepts behind all of the practice they are doing. Additionally, while the practice in Harcourt texts provides a lot of the basic skills instruction students will encounter on timed tests and the like, they are not given as many opportunities to apply skills as they are in the EDM materials.

While teachers said that the EDM materials definitely presented a high degree of rigor and challenge to students, they sometimes worried that the materials are too challenging for some students. Teachers allowed that Harcourt provided some high level mathematics problems but said it does not provide the same level of work that is present in EDM materials. In the words of one mathematics coach: "[Harcourt] moves students to higher levels of math but not higher levels of thinking." He continued by saying that Harcourt tells students to "do this to get to that…It doesn't teach students to think. There's no exploration, no discovery."

Meeting the Needs of All Students

A major focus of our school-level interviews was on understanding staff views about how well the two math programs meet the needs of all of their students. The contrasts drawn by respondents are summarized in Table 7 below.

TABLE 7

MEETING THE NEEDS OF ALL STUDENTS- RELATIVE STRENGTHS REPORTED BY PPS STAFF

	Everyday Mathematics	Harcourt Math
Engaging and hands on	X	
Supports small group work and differentiated instruction	X	
Challenges proficient and advanced students	X	
Practice and pacing work well for below basic students		X

EDM was overwhelmingly viewed by staff as being engaging and hands-on, drawing students in and leading them to take ownership of math through the use of games, activities, and classroom routines. For teachers who had switched to Harcourt this contrast was particularly clear, with many finding Harcourt “dry” by comparison. As one third grade teacher put it, “Harcourt overwhelms kids with practice but it is all pretty dry- all paper and pencil. I miss the games and manipulatives. I’m having a harder time keeping the kids engaged. I still pull out those EDM games for a more engaging way to practice.” For students whose motivation and attitudes towards mathematics are undermining their achievement, EDM was seen as having “hooks” to draw students in. PPS teachers also felt that EDM is better designed for small group work, in which teachers are able to differentiate instruction by providing a range of activities and approaches within a single classroom. Harcourt, with its largely whole-class instructional design, provides less support for teachers in differentiating instruction, beyond providing extra remediation or challenge worksheets that can be given to individual students. Given the current district-wide focus on differentiating instruction to meet student needs, this is a particularly significant difference in the design and implementation of the two programs.

Given that teachers praised the skills practice in Harcourt and the level of rigor in EDM, it is not surprising that many staff saw EDM as more suited for higher-achieving students and Harcourt as meeting the needs of students who struggle in math and need extra practice and reinforcement. As one coach in an EDM school put it, "Everyday Math is fantastic for our kids who are above proficiency. There is lots of enrichment that lets the kids go further in math, more situations where they get to apply the math. They just have to think more." From the point of view of a Harcourt teacher, Harcourt was seen as providing insufficient challenge for many students: "For the brightest students I'd give it maybe a 6. What it lacks is taking them to the next level, challenging them. Even for the average students I find I can skip a lot of the chapter. They just don't need all that practice on the basics."

However, teachers felt strongly that the extensive practice in Harcourt *was* needed for students who struggle, and that EDM simply moves too quickly for those students. A coach in an EDM school lamented, "The spiral concept of moving on before mastery is a nightmare. It gives kids nothing to hold onto. The level of frustration in classrooms is high. Our low kids need to practice something and master it before moving on. The EDM pacing is brutal for them- you just have to plow on and hope they pick it up later."

It should be noted that while the majority of interviewees felt that EDM did not work well for below basic students, they did not all feel that Harcourt's focus on repetition and traditional worksheet and computer skills practice was the answer. Some teachers argued that all the skills practice in Harcourt was just "more of the same," and that struggling students might need the kinds of alternate approaches to the material provided by EDM rather than practicing something they had not understood to begin with. In particular, some teachers argued that the manipulatives in EDM provided a kind of concrete access to mathematical concepts that can be highly beneficial for students who struggle to grasp abstract concepts. And as one first grade teacher noted, games are helpful in motivating below basic students because “they aren’t the type of students to memorize, to do homework, but they want to win the games. It makes them step up.

Using the Programs in the Classroom

A final cluster of issues that surfaced in our interviews centered around the experience of implementing the materials in the classroom, including their clarity, accessibility, and ease of use. These contrasts are summarized in Table 8:

TABLE 8

USING THE PROGRAMS—RELATIVE STRENGTHS REPORTED BY PPS STAFF

	Everyday Mathematics	Harcourt Math
Easy to implement out of the box		X
Clear where to focus		X
Mathematics familiar to most teachers		X
Looks familiar to parents		X
Quality manipulatives, tools, and routines	X	

Numerous teachers and coaches used the language of Harcourt being much easier to use “out of the box” or talked about being able to “just open up the book and teach.” By contrast, EDM was seen as requiring much more careful review and planning while preparing to teach. Staff did not all staff think that an “out of the box” program is necessarily a good thing, noting that the preparation that goes into planning an EDM lesson may yield a deeper understanding of the material and thus higher-quality instruction. Coaches were particularly likely to make this point. A third grade Harcourt teacher argued, “EDM is more challenging to the teacher understanding of math. It makes teachers think as well and that is a good thing! With Harcourt you can just open the book and start reading it." Coaches also noted, however, that this ideal of thoughtful lesson planning must be balanced against real world conditions in which teachers do not always have or take adequate time and sometimes do just open up the book and teach. Numerous teachers worried that EDM's denser lessons would be harder for a new or substitute teacher to prepare and teach well and noted it had taken them several years to use the material comfortably. In such cases, Harcourt, being easier to implement as intended, may yield a higher-quality lesson.

It should be noted that the widespread contention among PPS staff that EDM is relatively challenging to implement well is supported in the research literature regarding implementation of EDM and other inquiry-based mathematics programs (Banilower et al. 2006). Implementation challenges with EDM cited by PPS staff stemmed from both lesson design and content. In terms of design, teachers felt that the spiral structure made it difficult for both teachers and students to know where to focus on a given day. In contrast the lesson objectives in Harcourt's more self-contained lessons are simple and clear. In terms of content, EDM presents mathematical constructs in ways that may be unfamiliar to teachers from their own K-12 or university educations. Thus, it may be harder initially for teachers to "see the math" and grasp how best to reinforce it with students. A coach in an EDM school commented that "Teachers who are strong in math love this program. If you are insecure in math yourself, this is not the curriculum for you….Those teachers who are strong in math have the trust to let the kids go, let them do the thinking, which is the paradigm shift in Everyday Math." In fact this school had recently shifted to having math taught by "math specialists" rather than self-contained classroom teachers. The coach reported much greater success with EDM now that it was being taught by teachers who (1) had strong math content knowledge, and (2) had fewer other subjects to prepare and could really dig deep in math. District-wide, recognizing the increased content and implementation demands of EDM, PPS has invested heavily in professional development to deepen the mathematics content knowledge of staff.

Additionally, EDM is likely implemented to a higher level in PPS schools where teachers trust that their fellow teachers at various grade levels are fully implementing the math program. Thus, those teachers do not need to worry that their students are not building a foundation of mathematics concepts and skills that will "spiral back" and be taught to mastery in subsequent grades. In response to a question about whether the design of EDM works for students, a teacher at one school explained that it does. He qualified his response, however, by saying, "We're an unusual building… We teach [EDM]. We all teach it. Here, I know the students have all had [EDM]. I'm secure in that. They [the other teachers] have got my back." The teacher further explained that because he has taught both fourth and fifth grade, he is able to see how students progress through a spiral program such as EDM, although other teachers may be less comfortable with such an unfamiliar approach.

Even more than familiarity to teachers, familiarity to parents was cited as a challenge in using EDM, while Harcourt “looks like how they were taught to do math, so they are comfortable with it.” Teachers argued strongly that EDM creates challenges in working with parents, because the unfamiliar presentation of mathematical ideas makes it harder for parents to support students with their homework. Most teachers of Harcourt spoke about a definite reduction in letters and complaints from parents about not understanding their children's homework compared to when they were using EDM.

In terms of classroom implementation, the only aspect where PPS teachers gave EDM a clear edge over Harcourt was in the quality of their manipulatives, tools, and classroom routines. In fact, many teachers now using the Harcourt program have held onto and continue to use these EDM materials.

Upgrades in the Newly Released EDM3 Materials

Two of the four EDM schools in our sample began piloting the newest EDM materials—EDM3—this fall. Although this is a very small sample and they had only been using the new materials for about two months when we spoke to them, we did gather some information about the extent to which the newest version of the program addresses some of the weaknesses and challenges identified above. Most staff felt that EDM3 was a substantial improvement over the previous version. Specifically, they found the materials much more clear and teacher-friendly, particularly in terms of making the lesson design and the logic of the spiral more evident. They also praised improved components for differentiating instruction on both the high and low ends. They found the formal assessments much improved and the ongoing formative assessments easier to manage, still demanding in terms of teacher time but yielding rich information about student strengths and weaknesses. Finally, they noted that the math language and vocabulary are more explicit in both the teacher and student materials, in ways that will benefit students on tests. Not all teachers have been won over, however. While noting the above improvements, some teachers retain fundamental objections to the underlying design of EDM, particularly the spiral concept of introducing some ideas that are not mastered before moving on. Some teachers continued to argue that there is not enough “practice” in EDM, although this may be an issue of terminology since the practice in EDM comes largely from games and hands-on activities rather than from worksheets.

Patterns of Supplementation

Nearly every teacher interviewed mentioned using at least some supplementation to meet the needs of all students in his or her classroom. The patterns in this supplementation mirrored teachers' concerns about the weaknesses of each program. That is, teachers supplemented EDM with worksheets and skills practice in the classroom and as homework because they felt that EDM lacked that basic skills instruction and practice. Similarly, teachers who felt that Harcourt lacked a focus on conceptual development and engaging activities supplemented the program with activities that would challenge students to think and talk more with one another. Interestingly, most of the Harcourt teachers said that they were using or wanted to use EDM materials to address Harcourt's weaknesses, particularly favoring the routines, games, and manipulatives that are part of the EDM program. As one Harcourt teacher reported, “I feel blessed to have worked with both, so now I can pick and choose what my kids need. I like Harcourt as my everyday book because of the sequencing and all the practice, but it can get pretty dry. Everyday Math is much stronger in developing number sense and getting kids engaged in thinking about math- so I continue to draw on a lot of their games and activities. My lessons in this curriculum (Harcourt) are much stronger because I have had all that background in Everyday Math.”

These patterns in supplementation are important to keep in mind, as they make impossible any "pure" analysis of the implementation and achievements of each program. In addition, these patterns suggest that teachers want to bring diverse materials into the classroom that will meet the needs of all students. However, many teachers brought up the issue of supplementation reluctantly because they believed that the district did not condone such supplementation. More than a few teachers said that although they thought the district would not approve of the supplementation they were doing, they had to reach students whose learning needs were not necessarily met through the use of a single math program.

Search for "A Middle Way"

The nearly universal supplementation found in our interview sample reflects a strong teacher belief that no one package of materials will ever meet all the needs of students and that teachers should be given both support and resources to use whatever strategies and materials will get their students to the goal. A number of interviewees asked us point blank whether the intent of this study was for the district to choose one of the current programs over another, and offered us the unsolicited opinion that neither program by itself was adequate. As one experienced fifth-year teacher said, "We are trying to jerry-rig a program that gives our kids basic skills AND problem solving. Why not give it to us? I'd like to have a program where everything you need is there. Imagine a first year teacher- how would they even know what was needed or where to get it?" Many teachers used similar terms to share their frustration with the inefficiency of each teacher trying to piece together a curriculum. Some even felt that this had to be done without support or consultation from colleagues because supplementation was officially forbidden. A coach in a Harcourt school put it plainly, "There is not a curriculum out there that fills all the needs. Whatever they adopt, they should leave room for flexibility to supplement to meet student needs. We could really use some district-level guidance and resources on how to tailor and adapt instead of every teacher trying to figure it out on their own. Guidance and support, not the math police like we've had."

Interestingly, although we were not conducting formal interviews with principals in the schools we visited, a number of them felt so strongly about this topic that they made sure their opinions were heard. One principal made a distinction echoed by other staff members between a full-fledged curriculum and a set of materials: “The district does not have a math curriculum. They have math materials. A curriculum tells us what every child needs to know at the end of each grade. No one set of materials will get you all the way there. The problems we’ve had in math over the years have come from insisting on sticking to one set of materials rather than focusing on the goals and giving students what they need to get there. We need to be able to do what is best for kids and not live in fear of discipline or politics or board members getting involved. Give us goals, judge us by the results not by what materials we use.”

Our research suggests that in many classrooms and schools, teachers and whole faculties are trying to find their way to this middle ground themselves, starting with a focus on goals and piecing together materials and strategies that will help their students succeed. This suggests an opportunity for PPS to channel this process and harness the expertise of its staff to develop a fully articulated mathematics curriculum that provides teachers with strong core materials along with guidance and supplementary resources to differentiate instruction to meet students' needs.

CONCLUSION

Although EDM and Harcourt appear quite different in design, our comparison of two years of results finds no evidence that they produced different effects in achievement in Pittsburgh, overall or for particular subgroups of interest. The lack of difference may result in part from the fact that the programs as implemented in PPS are less different in practice than in theory, as a result of adaptations made by teachers who sometimes directly borrow from one program to supplement the other. Indeed, this mixing of programs may also explain why we find no evidence that students’ academic performance is harmed after they switch programs. It is possible that differences will become apparent in the future; two years is not a long time, particularly given that all of the students in both programs began their elementary education with

EDM. Later, it may be possible to compare students who have had EDM in all grades with those who have had Harcourt in all grades, but for now, it is impossible to know whether such a comparison will favor Harcourt or EDM. Moreover, we have no evidence as yet regarding whether one program or the other is better suited to preparing students for the math they will learn in middle and high school.

As previous research has shown (Gill, Engberg, and Booker, 2005), student achievement varies widely across Pittsburgh's elementary schools, and much of the variation appears to be attributable to differences in instructional performance in schools. Here we show that those differences are not related to the specific math program in place. Nonetheless, PPS' efforts to increase instructional performance and consistency district-wide as part of the Excellence for All initiative might usefully be extended to include elementary math, as many of the school staff we interviewed implicitly or explicitly suggested. PPS staff have provided information that not only helps to explain the absence of an achievement difference between the two programs, but also suggests a direction the district might take—toward the development of a comprehensive and ambitious curriculum in elementary math rather than mere program materials—that might potentially promote mathematics achievement district-wide. The good news is that this direction is entirely consistent with PPS' existing instructional initiatives.

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APPENDIX: SCHOOL STAFF INTERVIEW PROTOCOL

PPS Elementary Math Curriculum Implementation/Impact Evaluation

Mathematica Policy Research, Inc.

Interview Protocol for Teachers and Coaches

INTRODUCTION/STUDY OVERVIEW

As you know, the district is currently reviewing its elementary math program and has piloted the Harcourt program in eight schools over the last two years. The district has asked us to help them assess the experiences of schools implementing both Harcourt and Everyday Math and the impacts on students. Your school was one of eight chosen randomly (4 using Harcourt, 4 using Everyday Math) for this research. Your frank and honest comments will help the district in making this important decision. Your comments will not be associated with your name or even your school's name. If you have experience using both curricula, I'd especially like you to compare the two on some of the dimensions we will talk about. Do you have any questions before we begin?

1. What would you say are the strengths/weaknesses of this program in terms of helping students master core math skills appropriate to their grade level?
2. What would you say are the strengths/weaknesses of this program in terms of helping students develop conceptual understanding and problem-solving skills appropriate to their grade level?
3. How well does the program support rigorous/higher level thinking and help students "make sense of math"? Are higher level concepts adequately scaffolded?
4. How well does this curriculum meet the needs of students who start out below basic?
5. How well is this program aligned to the eligible content standards for the grade(s) you teach and to the PSSA itself?
6. Is it your sense that most other teachers in this school feel the same way about the curriculum?

7. What would you say are the strengths/weaknesses of this program in terms of your ability to communicate with parents about what their students are working towards in math and the ability of parents to support their students?

8. How useful are the program's formative and summative assessments as tools for differentiating instruction? Do the data tools provided by the program make the data accessible and easy for you to manipulate and interpret?

9. What would you tell a fellow teacher about the materials themselves? Are they easy for you to use? Is the design of the lesson and what you should focus on clear? How much and what kinds of supplementation/extra planning do you feel the need to do?

10. How well does the sequencing and flow of the program work, for example how are lesson objectives/learning goals introduced, practiced, and secured throughout the year, and learning sustained/supported over time?

11. Tell me about any professional development you received on using this curriculum- from the developer, the district, or at the school level? How well did it prepare you in terms of understanding the material itself? In terms of understanding how to implement it with your students?