Significant Improvements in Statewide Test Results As A Consequence of Using A Japanese-Based Supplemental Mathematics System, Kumon Mathematics, in an Inner-Urban School District

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Abstract

This paper provides an evaluation of the effects of using the "Kumon" method for supplementing the teaching of mathematics in the inner-urban school district of Pontiac, Michigan. Michigan Educational Assessment Program (MEAP) test scores are cited for Herrington, Owen, and Crofoot elementary schools, which used the Kumon program during part of their ninety minutes of daily mathematics instruction, and demographically matched Emerson Elementary School, which did not use the Kumon program during its ninety minutes of daily mathematics instruction. In 2003, Emerson had 4.5% of its students exceed Michigan standards. In 2004 that number was 8.6%. At Herrington Elementary School, however, the MEAP scores rose from 39.7% to *89.1%* of students exceeding state standards during the same single year period. Crofoot went from 0.0% of students exceeding Michigan state standards in 2003, to a remarkable *58.1%* exceeding standards in 2004. Owen also showed substantive improvements.

The research project, a joint effort between Oakland University's School of Engineering and the School District of Pontiac, reveals that supplementation with the Kumon method as a partial replacement for a traditional mathematics program appears to result in significant improvements in statewide Michigan Educational Assessment Program test scores for mathematics.

Background

The Pontiac School District is an inner-urban school district located near Oakland University, in Oakland County, Michigan. The performance of Pontiac students on the mathematics section of mandated state tests (Michigan Educational Assessment Program—MEAP) and nationally normed tests is below that of students in surrounding, wealthy school districts such as Rochester and Avondale.[1] To assist Pontiac in improving their students' mathematics skills, Oakland University teamed with Kumon, North America, Inc. (KNA) to provide a supplemental mathematics program for approximately twenty minutes per day to each student in selected elementary schools. A "bottom up" approach—improving mathematics first in the elementary school, rather than high school

levels was felt to be critical. A program that excites students about mathematics works best if it is implemented at ages before the child has been turned off to mathematics.

Kumon works by providing a comfortable, incremental learning that places emphasis on back to basics building of automotacity in mathematics through practice, much in the same way children learn to play musical instruments well. The details of initial work in this Pontiac/OU/Kumon effort, and research related to why the Kumon method is so powerful, are provided in "Using the Kumon Method to Revitalize Mathematics in an Inner Urban School District," which was presented at the 2003 ASEE Annual Conference.[2] Initially, the Pontiac/OU/Kumon mathematics program started in five elementary schools, but two schools, despite purchasing the materials, did not use them (the materials remained largely unwrapped and in the original boxes, or were left untouched on the shelves), or consistently and did not follow the implementation instructions critical to the method. Therefore, results are presented only for the three schools that implemented the Kumon program, as contrasted with a similar school from the same district that never purchased or used the Kumon program. The demographics of the schools involved are shown in Appendix A.

The Michigan Education Assessment Program (MEAP)

A description of the MEAP tests is provided on the Michigan Department of Education website. "Elementary and middle school MEAP tests (4th, 5th, 7th and 8th grade students) are offered once each year in January-February. Retests are not offered. Tests must be taken in the appropriate grade (students must take 7th grade tests while in 7th grade; 8th grade tests while in 8th grade). Each elementary and middle school MEAP test subject, i.e. Math, Science, Social Studies, Reading, Writing, combined English language arts (ELA) and Listening, has its own set of performance categories:

- Level 1: Exceeds MI Standards
- Level 2: Met MI Standards
- Level 3: At Basic Level
- Level 4: Apprentice

Elementary and middle school MEAP scores are reported as percentages (for example, a score of 42.5 means 42.5% of the students whose scores were included performed at the level of achievement shown)."

Results and Discussion

The MEAP scores for the 2002-2003 and 2003-2004 school years are shown in Table 1 for four schools. The first column shows scores for Emerson Elementary School, which did not use the Kumon program; these results are contrasted with those of Owen and Crofoot elementary schools, which have implemented the Kumon program continuously since the 2003-2004 academic year; and Herrington Elementary School, which has implemented the Kumon program continuously since the 2002-2003 academic year.[†] It should also be noted that the Pontiac School District had 34.7% of their students exceed

[†] Since MEAP tests are taken during the January-February timeframe, the 2002-2003 academic year would show scores in 2003.

Michigan state standards on the 4th grade MEAP tests in 2004, a score buoyed even above the state average of 28% by virtually perfect or unusually high scores from several schools. Interestingly, the students from these high-scoring schools appear to do no better than students from other, dramatically lower scoring schools when the students arrive at middle school—a result typifying the concerns of many about the validity of high-stakes testing. However, after many hours of interaction with the principals and teachers of the schools involved in this study, it is felt by the principal authors that the MEAP scores of the four schools presented here are indeed valid.

During the years of this study, all four schools used the Houghton-Mifflin Math Central teaching materials,[3] except Herrington, which piloted the use of Everyday Mathematics[4] in their third grade class during the 2003-2004 school year. However, the schools using Kumon replaced part of their conventional mathematics curriculum time with twenty minutes of Kumon method mathematics time plus five minutes for switching gears and allowing the students to obtain their daily Kumon worksheets. Those schools using the Kumon method did *not* devote any extra time to the daily mathematics curriculum.

Table 1: 2003 and 2004 Michigan Educational Assessment Program (MEAP) Results in Mathematics for Grade 4.[1]

	Emerson		Owen		Crofoot		Herrington	
	2003	2004	2003	2004	2003	2004	2003	2004
Level 1: Exceeded MI Standards	4.5%	8.6%	3.3%	9.1%	0.0%	58.1%	39.7%	89.1%
Level 2: Met MI Standards	31.8%	17.1%	18.3%	54.5%	39.1%	29.0%	31.0%	10.9%
Level 3: At Basic Level	31.8%	51.4%	58.3%	34.5%	52.2%	6.5%	24.1%	0.0%
Level 4: Apprentice	31.8%	22.9%	20.0%	1.8%	8.7%	6.5%	5.2%	0.0%
Number Included	44	35	60	55	23	31	58	46

By 2004, most Herrington fourth graders were exposed to the Kumon mathematics supplemental program during most of third grade and half of fourth grade. The results are startling: from having 39.7% of their students exceed Michigan State standards in 2003, by 2004, *89.1% of Herrington's students exceeded Michigan State standards*. The daily practice, and resultant solid foundation in mathematics, appears to have taken root. Moreover, Herrington teachers noted a spillover effect—the discipline of daily practice and the routine of quiet that the Kumon technique requires was noted by many teachers as also having a direct positive effect on reading and writing—scores on those tests rose as well, although not in as marked a fashion.

Owen and Crofoot Elementary Schools began to solidly implement the Kumon program during the 2003-2004 academic year, after scattered, poor implementation efforts in the latter part of the preceding year. In 2004, the number of students exceeding Michigan

standards jumped by nearly a factor of three at Owen, from 3.3 % to 9.1%, while the number meeting Michigan standards grew from 18.3% to 54.5%--a substantial improvement for the school as a whole. At Crofoot, the differences were even more dramatic—*the number of students exceeding Michigan state standards grew from 0.0% to 58.1% in a single year!*

The difficulties in initial implementation at Owen, Crofoot and even, to some extent, at Herrington relate in large part to the fact that most teachers in Pontiac have become accustomed to not having to correct or grade mathematics papers on a daily basis, and consequently are reluctant to take on such a responsibility until they have seen that the method works. This is the sort of chicken and egg problem that, in our experience, school principals are best able to handle through firm leadership. Firm principals are willing to not only inspire teachers to use the new teaching method, but are also willing to discipline those lax teachers who do not use the worksheets or who do not bother to correct the worksheets after they are used. A major advantage of the Kumon method is the ability it provides for administrators to easily check and verify that teachers are using the system and teaching and providing feedback to students about mathematics on a daily basis *at that particular student's level*. Because daily worksheets must be graded and the results entered into a set of grading sheets, an administrator can tell at a glance which class is not implementing the Kumon curriculum materials properly. This accountability also helps promote enthusiasm by curbing unfair criticism (in our experience, always from teachers who have not been using the program), that the program does not work.

Additionally, the effect of the Kumon administrators and Oakland University engineering professors in coaching the teachers as to how to effectively teach mathematics cannot be emphasized enough. For example, some teachers seemed to feel during initial training sessions that understanding was more far more important than accuracy in mathematics, rather than realizing that accuracy is a often a reflection of understanding. (Quibbling aside, it is clear that a student who "understands" why multiplying three times two results in six, but who often answers seven or ten instead, cannot do multiplication.) Another commonplace error on the part of elementary school teachers was that they believed students should not be encouraged to do problems quickly—spirited discussion arose to this effect during one of the initial Kumon training sessions. When an engineering professor opined in response that an engineer earning $100,000 a year—a fairly typical salary—could hardly be expected to take a year to do the mathematics involved in designing a simple circuit, the teachers fell silent. In fact, many teachers voiced the opinion that they were glad to have contact with engineering professors; that somehow in the daily routine of education they themselves lost sight of the importance of mathematics in solving important real world problems.

Conclusions

Daily supplemental practice in mathematics using the Kumon methodology appears to provide for substantial improvement in statewide assessment tests. A solid foundation in mathematics appears to take at least one year, and preferably two, for most students to develop before fourth grade testing, however, once the foundation is in place, the results in increase in students' abilities as noted on statewide tests appears to very significant.

References

[1.] Michigan Department of Education, MI School Info Online, http://www.mcgi.state.mi.us/mischoolinfo/, 2005.
[2.] Oakley, B., Lawrence, D., Burt, W., Boxley, B., and Kobus, C., Using the Kumon Method to Revitalize Mathematics in an Inner-Urban School District, in *ASEE Conference*, Nashville, TN, 2003.
[3.] Online information available at http://www.eduplace.com/math/mathcentral/
[4.] Online information available at http://everydaymath.uchicago.edu/
[5.] Demographic data purchased in report form from ESRI, Inc., 380 New York Street, Redlands, CA 92373-8100, Phone: (909) 793-2853, company website at www.esri.com.

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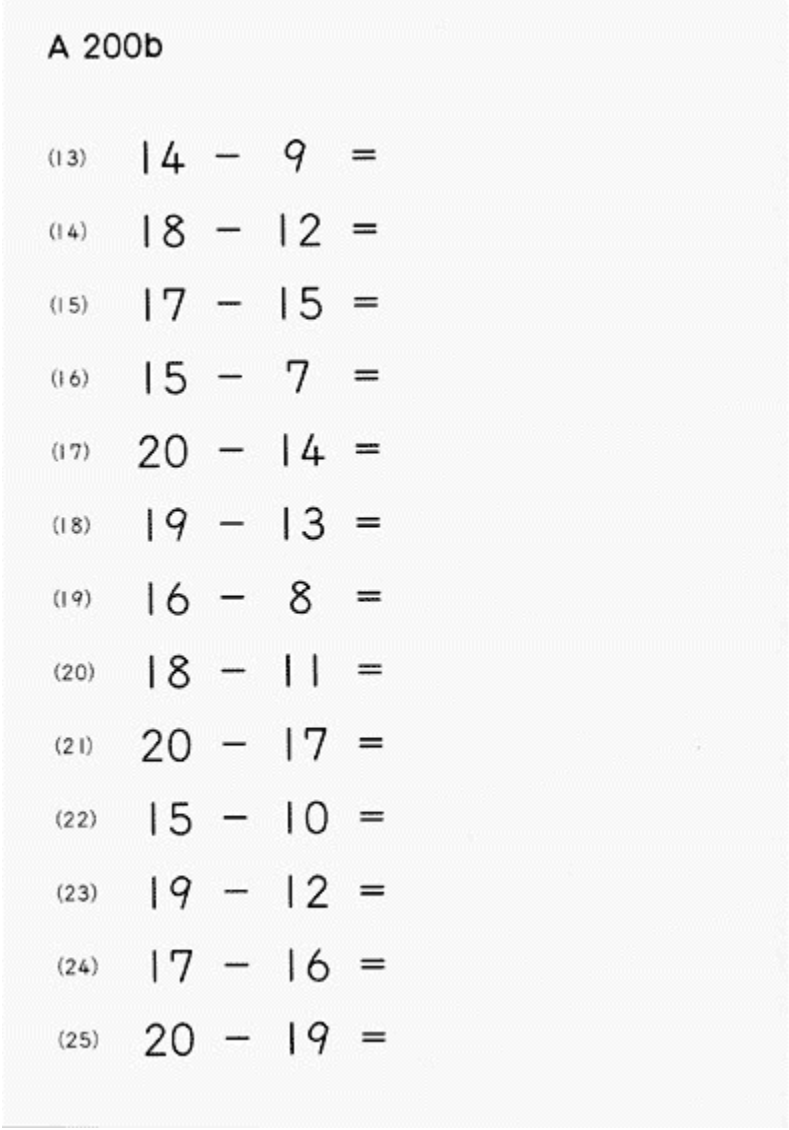
Appendix A: Demographics of schools involved in Kumon mathematics study In Pontiac, Michigan (2004).[5]				
Item	Owen	Herrington	Crofoot	Emerson
Average Household Size	2.67	2.72	2.75	2.71
Median Household Income	$ 37,391.00	$39,920.00	$ 38,689.00	$ 40,467.00
Average Household Income	$ 50,110.00	$52,024.00	$ 55,780.00	$ 52,109.00
Population	34265	30979	45955	30953
0-4	3,209	2,745	3722	2754
	9.4%	8.9%	8.1%	8.9%
5-14	6,147	5,362	7605	5322
	17.9%	17.3%	16.5%	17.2%
15-19	2,587	2,336	3539	2311
	7.5%	7.5%	7.7%	7.5%
Race				
White Alone	17266	11086	17323	11929
%	50.40%	35.80%	37.7	38.5
Black Alone	10,389	15,685	22716	14227
%	30.30%	50.60%	49.4	46
Asian Alone	1,518	919	1340	1090
%	4.40%	3%	2.9	3.6
Hispanic Alone	6,322	3,725	5649	4402
%	18.50%	12%	12.3	14.2
Educational Attainment 25+				
Less than 9th Grade	10.3%	7.9%	9.0%	8.9%
9th-12th Grade, No Diploma	22.8%	19.3%	21.3%	20.0%
High School Grad	32.7%	32.4%	30.8%	32.3%
Some College, No degree	20.3%	23.0%	21.1%	22.3%
Associates	4.7%	5.0%	4.8%	4.8%
Bachelors	6.5%	8.6%	8.8%	8.0%
Masters+	2.7%	3.7%	4.2%	3.7%
Education :total				
Average Spent	$ 772.67	$ 766.34	$ 847.23	$ 777.32
Spending Index	77%	76%	84%	77%

Appendix B: Typical Kumon worksheet at Level A



A 200b

(13) 14 − 9 =

(14) 18 − 12 =

(15) 17 − 15 =

(16) 15 − 7 =

(17) 20 − 14 =

(18) 19 − 13 =

(19) 16 − 8 =

(20) 18 − 11 =

(21) 20 − 17 =

(22) 15 − 10 =

(23) 19 − 12 =

(24) 17 − 16 =

(25) 20 − 19 =

Appendix C: Worksheet Level Outline

WORKSHEET LEVEL OUTLINE

7A	Counting. This level aims to thoroughly familiarize the student with numbers through counting and tracing.
6A	Reading numbers. Level 6A enables the student to read numbers up to 30 and broadens his/her understanding of the order of numbers.
5A	Drawing Lines, Reading Numbers, Reciting Numbers. Level 5A enables students to read numbers up to 40 and recite numbers up to 50. Upon completion of this level, students will also be able to demonstrate pencil control when drawing lines.
4A	Writing Numbers. Level 4A develops the students' ability to see the sequence of numbers from 1-220. This level also enables the student to write numbers in the correct way and is helpful for learning addition.
3A	The aim of level 3A is to enhance the students' number writing skills and to introduce the mental addition of numbers from 1 to 5.
2A	In this level develops student's skills in the addition and subtraction of numbers up to 10.
A	Level A focuses on the development of mental addition skills. The student's ability to mentally calculate, will be used in each area of Math in the future.
B	The aim of Level B is for students to develop skills in written addition and subtraction using the mental calculation skills learned throughout Levels 3A-A.
C	Multiplication and Division. Level C enables students to memorize the 2-9 multiplication tables, multiply by 1 digit numbers and divide by 1 digit numbers and find the remainders.
D	Division by 2- Digit Numbers and Introduction to Fractions. This level enables students to perform long multiplication and long division, rewrite improper fractions as mixed numbers and reduce fractions.
E	The Basics on Calculating Fractions. Level E enables students to add, subtract, multiply and divide fractions and decimals. When students complete this level they will be able to rewrite fractions as decimals and vice versa.
F	Mixed Four Operations With Fractions and Decimals. Level F concludes the study of arithmetic and acts as a springboard to algebra. This level enables students to - calculate a mixture of the four operations with fractions and decimals; - calculate the four operations with decimals including vertical calculation; - solve word problems using the concept of fractions.
G	Level G introduces students to basic algebra. Upon completion of this level, students will be able to calculate positive and negative numbers, simplify basic algebraic equations and solve one variable linear equations.
H	Simultaneous Linear Equations and Functions. Level H enables students to - solve simultaneous linear equations; - work with linear functions on the number plane; - simplify monomials and polynomials.
I	Factorization, Square Roots and Quadratic Equations. Level I will help students develop higher mathematical skills. When students finish this level, they will be able to - factorize polynomials; - calculate with square roots; - solve quadratic equations; - work with linear functions on the number plane; - use the Pythagorean theorem.
J	Expansion of Polynomial Products and Factor Theorem
K	Quadratic Functions, Fractional Functions, Irrational Functions, Trigonometric Functions and Exponential Functions
L	Trigonometric Theorems, Tangent Lines of Circles, Equations of Straight Lines, Quadratic Curves
M	Arithmetic Sequences, Differential and Integral Calculus
N	Surface Vectors, Coordinates in Space, Equations of Lines and Planes, Matrices
O	Infinite Geometric Series, Limits of Functions, Differentiation, Applications of Differential Calculus
P	Indefinite Integrals, Definite Integrals and Differential Equations
Q	Permutations, Combinations, Binomial Theorem, Statistics