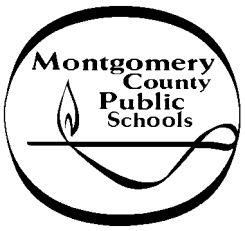

Executive Summary

Evaluation of the Singapore Math Pilot Program: Year 1 Report of Findings

Dr. Susan Gross
Suzanne Merchlinsky

Office of Shared Accountability

May 2002

Dr. Frieda K. Lacey, Office of the Superintendent of Schools

Dr. Wesley L. Boykin, Office of Shared Accountability

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Executive Summary

Background

In spring 2000, Superintendent Jerry D. Weast announced his intent to pilot the Singapore Math program in several Montgomery County Public Schools (MCPS) elementary schools in an effort to improve and accelerate mathematics instruction.[1] Results of international studies of mathematics achievement consistently showed Singapore students to be at or near the top in mathematics performance.[2] Comparison of Singapore Math curriculum materials to the list of student objectives assessed by MCPS's Instructional System in Mathematics (ISM) assessments showed that students who participated in Singapore Math were exposed to mathematics topics earlier than was typical in MCPS. In many cases, Singapore Math presented the topics as early as two years before they were assessed in ISM. The purpose of the pilot was to determine whether, and to what degree, implementation of the Singapore Math program in Grades 1-5 in four selected schools could 1) alter how mathematics concepts were presented by teachers, and 2) elevate and accelerate the mathematics performance of MCPS elementary school students. The elementary schools selected for the pilot were: College Gardens; Dr. Charles Drew: Highland View; and Woodfield.

The Evaluation Study Design

A Model of Instructional Change

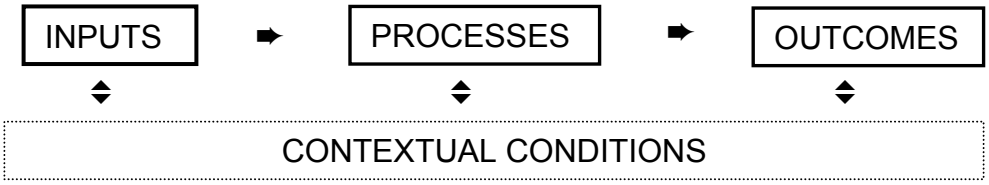
The evaluation was conducted by the Office of Shared Accountability (OSA). Three types of variables which work together in the greater context of the school system and schools were investigated:

- inputs – the resources provided in the pilot;
- processes – what people do to implement the pilot; and
- outcomes – the effects of pilot implementation.

Figure 1 illustrates this model.

[1] MCPS. *Investing in the Call to Action, Fiscal Year 2001*, p. 5.
[2] Mullis, Ina V. S., et al. *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Boston, MA: TIMSS International Study Center, Boston College, June 1997, p. 24-25.

Figure 1: A Model to Frame the Evaluation Design



Instruments and Methodology

Several evaluation instruments and procedures to gather data for this study were used.[3] They included the following:

- observations of in-service training sessions provided to teachers;
- interviews with teachers, principals and Central Office staff;
- observations of classroom instruction;
- focus groups with parents and students; and
- analyses of system-wide mathematics assessments, quarterly assessments developed for the pilot program, and 6th grade mathematics course enrollment for students who participated in Singapore Math as 5th graders.

Two types of control schools were planned for the study: Control A and Control B schools. This design allowed for a comparison of three combinations of inputs:

- full dosage – all inputs provided (Singapore schools);
- partial dosage – some inputs provided (Control A schools); and
- no dosage – no new inputs provided (Control B schools).

However, due to implementation problems at the outset of the pilot, the evaluation findings focus primarily on the effect of the curriculum and training on the four Singapore pilot schools.

The Evaluation Questions

The evaluation questions focus on the potential effect of the various components of the Singapore Math pilot.

1. What is the effect of the new curriculum (Singapore Math) on classroom instruction and student achievement?

2. What is the effect of teacher training on classroom instruction and student achievement?

[3] A full description of data collection activities and respondents may be found in the appendix.

3. What effect does the model of student assessment have on classroom instruction and student achievement?

4. If we wanted to expand the pilot to other MCPS schools, which aspects of the Singapore pilot would best lend themselves to other school contexts within MCPS?

Evaluation Findings

Implementation Issues

Due to the late start of the Singapore Math pilot, several aspects of the pilot were not implemented as fully or uniformly as might have happened if more lead time had been provided. These implementation problems impacted not only what happened in the schools involved in the pilot, but also created some limitations regarding what we were able to conclude after the first year's evaluation of the pilot through comparisons of the Singapore pilot and control schools.

- Late notification resulted in initial teacher resistance to participating in the pilot, insufficient time for MCPS's Office of Instruction and Program Development (OIPD) mathematics staff to fully prepare for the first summer training session, and uneven teacher participation in school year follow-up training.

- Incomplete communication with potential control schools resulted in delayed identification of the schools, a break-down of the training model for Control A schools, and uneven administration of the quarterly assessments.

- Uneven participation of teachers in the school year training sessions impacted many teachers' ability to fully implement the pilot components in their classroom instruction.

Many lessons were learned and changes were made during the second year of the pilot to address these implementation concerns.

- Training was restructured to better meet the specific needs of each Singapore pilot and Control A school.

- Control A teachers were invited to attend the summer 2001 training institute with the Singapore pilot teachers.

- Singapore pilot and Control A schools were given clearer guidance regarding how to handle the quarterly assessments.

A Combination of Factors Produced Change

The evaluation data suggest that both the curriculum and training contributed meaningfully to changes within the schools. The curriculum provided a structure and coherence to the mathematics program, and the training provided teachers with instructional strategies and deeper understanding of how students learn that were essential to effective implementation of the curriculum. It was not the Singapore Math materials in and of themselves that caused change in the classrooms. Rather, the successful schools were characterized by teachers and principals who embraced the concepts of change and worked together to develop a professional learning community. These characteristics included:

- regular attendance at training by the principal and teachers;
- development of a common vision for mathematics instruction;
- attention to the needs and concerns of parents;
- devotion of school resources (e.g., money, scheduling, and staff supports) to enhance the implementation of the Singapore curriculum; and
- leadership that the school principals gave to pilot activities and the degree to which they provided supports within the school to facilitate effective implementation of the curriculum and instructional strategies.

These characteristics were found extensively in two of the Singapore Math pilot schools (Schools 1 and 2), but were not found or were found in limited ways in the other two schools (Schools 3 and 4).[4] Moreover, the principal of School 1 used her leadership ability to completely restructure how the school would be organized to deliver mathematics instruction. Details of these efforts may be found in the appendix.

Based on the extent to which teachers were observed Singapore Math materials and strategies in classroom instruction in the pilot schools, the evaluation team concluded that:

- 18 percent of the Singapore pilot teachers were not using the Singapore Math curriculum or instructional strategies emphasized in the training sessions;

- 38 percent were attempting to use the curriculum and strategies but were struggling with them;

- 29 percent were experiencing moderate success implementing the curriculum and strategies; and

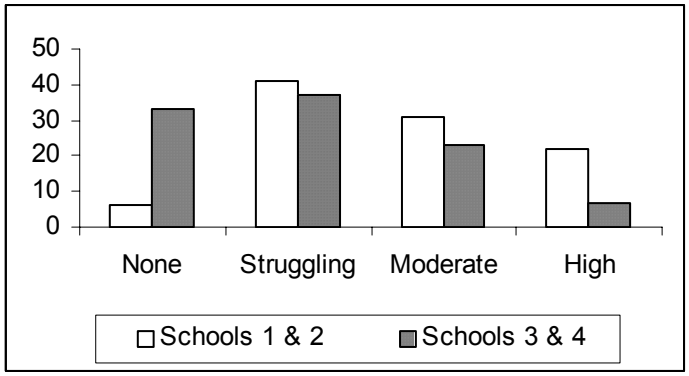
- 16 percent were highly successful in implementing the curriculum and strategies.

Implementation of the Singapore Pilot was more successful and pervasive in Schools 1 and 2, compared to Schools 3 and 4. This resulted in greater changes in classroom instruction and greater effects on students' mathematics performance. Figure 2 illustrates

[4] To preserve confidentiality, the Singapore pilot schools are referred to as Schools 1, 2, 3, and 4.

the difference in implementation success for teachers in Schools 1 and 2 compared to Schools 3 and 4.

Figure 2: Levels of Success in Implementing the Singapore Pilot in Schools 1 and 2 vs. Schools 3 and 4



The following comment illustrates one principal's view of the school's emerging vision for mathematics instruction:

> "Math is being talked about, and that is powerful. Teachers are discussing better ways to instruct children, and children are finding that they have the ability and skills to figure out problems. They are more confident in the ways they solve problems."

Students' Mathematics Progress and Achievement

Many teachers reported that their students made greater progress in mathematics in the first year of the Singapore pilot than they had in the past. Specifically, they reported that students had a deeper understanding of key mathematics concepts such as number sense, place value, measurement, and problem solving than they did in prior years; and they progressed more quickly through mathematics units than they did in prior years. Teachers in Schools 1 and 2 reported these changes in greater numbers than did teachers in Schools 3 and 4.

Analysis of 6th grade course enrollment for middle school students in fall 2001, compared to fall 2000, also showed some evidence of student progress related to implementation of the Singapore pilot.

- Students from Schools 1 and 2 had higher mathematics course placements than did students from the same schools in fall 2000. A smaller percentage of the 2001 6th graders were placed in Math A, compared to those placed in Math 6 or Math A in

2000, and conversely, higher percentages of the 2001 6th graders were placed in Math B or Math Investigations.

- Students from Schools 3 and 4 were placed in similar mathematics courses in fall 2001 and fall 2000.

Analyses of achievement data also showed consistent differences favoring Schools 1 and 2.

- In spring 2001 2nd grade students in Schools 1 and 2 significantly outperformed students in Schools 3 and 4 on the mathematics and mathematics computation sub-tests of the CTBS, and 4th grade students in Schools 1 and 2 significantly outperformed students in Schools 3 and 4 on the mathematics sub-test.

- Grades 2-5 students in Schools 1 and 2 significantly outperformed students in Schools 3 and 4 on the quarterly assessments that were developed for the Singapore pilot. The magnitude of the performance difference was largest in the upper grades.

- Third and fifth grade students in Schools 1 and 2 performed similarly on the MCPS mathematics CRTs in spring 2000 and in 2001. The performance of students in Schools 3 and 4 declined markedly during this period.

- Students in Schools 1 and 2 who were tested on the CRTs in both 4th and 5th grades maintained fairly even performance over time, but students in Schools 3 and 4 had substantial declines in their performance.

These findings suggest that, in the schools where implementation of the Singapore Math pilot was most prevalent, students made further progress and attained higher levels of mathematics achievement than did students in the schools where implementation was more uneven. Additionally, it appears that, even though the lack of alignment between the Singapore curriculum and the CRTs concerned principals and teachers, sound implementation of the pilot did not adversely affect students' performance on the CRTs, but ineffective or spotty implementation had an adverse effect.

Findings Related to Each Evaluation Question

Due to the limitations placed on the evaluation design by early implementation problems with the pilot, we cannot disentangle whether the changes observed in students' mathematics progress and achievement were the direct result of the Singapore curriculum, the teacher training, or a combination of both. Anecdotal information from principals, teachers, students, and parents suggest that it was a combination of both the curriculum and training that brought about the changes. Our observation data support the anecdotal information.

1. What is the effect of the Singapore Math curriculum on classroom instruction and student achievement?

Where the Singapore Math curriculum was implemented as designed, classroom instruction became more coherent. The curriculum enabled teachers to present mathematics concepts in a logical sequence, cover them in-depth, and include a new level of rigor in concept formation. The curriculum provided ways for teachers to build on students' prior knowledge and introduce a precise mathematics vocabulary into their lessons. These factors resulted in greater confidence on the part of students and improved mathematics performance. Specifically, the evaluation data showed that:

- the Singapore Math books provided an in-depth presentation of important mathematics content, and the scope and sequence provided a scaffolding of key knowledge upon which more complex topics could be developed;
- the Singapore materials offered a more challenging curriculum to students in a way that promoted problem solving and critical thinking skills;
- the precision of mathematical language (e.g., number bonds, fact families, part-whole, and algorithms) provided the foundation for concept development in basic areas such as number sense, place value and problem-solving;
- teachers exposed students to mathematics topics earlier than they did in prior years;
- teachers focused on topics in greater depth and spent more time on each topic; and
- this stress on depth rather than breadth of content was a paradigm shift for MCPS teachers.

These factors, combined, contributed to higher expectations for students and students responded well to the expectations. They were observed more consistently in Schools 1 and 2 than they were in Schools 3 and 4.

2. What is the effect of teacher training on classroom instruction and student achievement?

Training provided teachers with the strategies to take students from concrete, to pictorial, to abstract methods of solving mathematical problems. The training sessions provided teachers with a wider repertoire of instructional strategies that they were comfortable with. Specifically, the training showed teachers how to:

- effectively use manipulatives to support students' understanding;
- provide pictorial and model representations of mathematical concepts; and
- use these strategies to move students from concrete to abstract understanding.

In two key areas of mathematics instruction, the teachers in Schools 1 and 2 reported significantly greater benefits to their instructional practice when compared to teachers in Schools 3 and 4. These areas were:

- increased ability to employ a greater variety of instructional strategies; and
- increased ability to implement high-quality instructional materials.

Principals, teachers, and parents suggested that these changes positively impacted students' learning and attitudes towards mathematics.

Our classroom observation data showed that teachers in Schools 1 and 2 provided meaningful learning activities for students significantly more often than did teachers in Schools 3 and 4. We found that:

- students in Schools 1 and 2 participated significantly more actively in mathematics lessons than did students in Schools 3 and 4;

- students in Schools 1 and 2 spent significantly more time explaining their thinking than did students in Schools 3 and 4;

- students in Schools 1 and 2 spent less time practicing computation in isolation than did students in Schools 3 and 4 (not statistically significant); and

- students in Schools 1 and 2 spent more time solving problems or performing computations in a contextual setting than did students in Schools 3 and 4 (not statistically significant).

As a final note, teachers in all four schools felt least well prepared to recognize and respond to student diversity as compared to other areas of mathematics instruction. This may be an area worthy of further teacher training.

3. What effect does the model of student assessment have on classroom instruction and student achievement?

Principals and teachers felt positively about the new quarterly assessments. They reported that the quarterly assessments provided more information about students' strengths and weaknesses in math than was true with the ISM assessments, and tested a deeper level of understanding of mathematics than was true for the shorter, more frequently administered ISM assessments. However, there were some concerns about administering the quarterly assessments to all students in Grades 1-5. Some teachers and parents were concerned about students who had:

- gaps in their mathematics knowledge from prior years and might not be able to perform well on the assessments;
- limited English proficiency; or

- learning problems that interfered with their ability to take paper and pencil assessments.

Our data analysis did not produce any links between use of the quarterly assessments and gains in student achievement.

4. If we wanted to expand the pilot to other MCPS schools, which aspects of the Singapore pilot would best lend themselves to other school contexts within MCPS?

The totality of the data suggest several important factors to be considered in either expanding the Singapore pilot or implementing a new curriculum effort.

a) It is important that principals provide in-school supports to promote a common school vision of effective instruction and expectations for student achievement. Supports include:

   - providing materials and supplies to support the curriculum;
   - setting aside time during the school day for teachers to plan lessons and discuss students' performance; and
   - conveying the message that the new curriculum effort is important and relevant, and we will all dig in and do it.

b) Both teacher and principal participation in training is essential for effective curriculum implementation. The schools in which the teachers and principals participated fully in training opportunities made the greatest changes in classroom instruction and teachers' attitudes regarding what students could learn, and made the greatest growth in student performance.

c) Time and resources need to be provided to allow the curriculum implementation pro??cess to percolate and mature.

d) Materials and resources need to be provided for principals to inform parents of the curriculum change and obtain their acceptance of it.

It is evident that in two of the Singapore pilot schools staff spent considerable time and effort on implementation issues and changes in instructional practice. When they began the Singapore pilot, it was with the understanding that the pilot would be a 3-year effort. However, with the upcoming cluster-wide implementation of one of the two new elementary mathematics curriculum packages in Grades 1 and 2, principals of the Singapore pilot schools have some questions regarding whether it would be better to stay with the Singapore curriculum for a third year or switch to one of the two new curricula. On the one hand, there is something to be said for continuing the momentum of the Singapore curriculum for another year. On the other hand, massive training efforts are being mounted for teachers in Grades 1 and 2 in summer 2002, and principals and teachers in the Singapore pilot schools might feel they have been left behind if they do not partici-

pate in the training this year. To address these concerns, OIPD staff has provided assurances that there will be special training sessions this summer for teachers in Singapore pilot schools. In these sessions teachers will learn how the Singapore curriculum aligns with the new MCPS mathematics curriculum framework. OIPD plans on providing additional training to teachers in these schools next year if the schools adopt one of the new mathematics curriculum packages.

There are also concerns regarding the extent of alignment between the Singapore curriculum and the end-of-unit assessments that are being developed to support the two new elementary mathematics curriculum packages. It will be important to continue to monitor the progress of students in the Singapore pilot schools, whether they continue to be assessed on the quarterly Singapore assessments, or whether they are assessed on the new end-of-unit assessments. Most importantly, however, clear communication needs to be provided to the Singapore schools regarding interim and future steps that will be put in place to transition them into whatever mathematics curriculum is selected down the road as the "official" MCPS elementary mathematics curriculum.

Recommendations

Recommendation 1: Careful consideration should be devoted to the concerns of principals in the Singapore pilot schools as new pilot programs are rolled out. Transition activities to bring the Singapore pilot schools into the mainstream implementation of the new mathematics curricula will need to be formulated and communicated to the Singapore pilot principals and teachers. Additionally, as MCPS makes decisions regarding the effectiveness of the two proposed new pilot curricula for the coming school year, we need to be mindful of the amount of time that is needed for the implementation process itself, and the level of support schools will need to implement and then maintain the curriculum. These constraints must be considered as evaluation activities are proposed and carried out, and inferences about programmatic success are formulated.

Recommendation 2: Regardless of which curriculum program or textbook series is selected to support MCPS's continuing improvement of elementary mathematics, we need to provide training to teachers in effective strategies for teaching the curriculum. The adoption of a new curriculum may provide important structures for how mathematics should be taught or sequenced, but without training in effective instructional strategies, mathematics lessons will not change in meaningful ways.

OIPD will provide training to teachers in Grades 1 and 2 in summer 2002, and to teachers in Grades 3 through 5 in the Tier 1 Title I schools and the 6 non-Title I pilot schools. Similar training will need to be provided to the remaining teachers in Grades 3 through 5 as MCPS moves ahead with system-wide adoption of new elementary mathematics curricula. This training cannot be a one-shot experience. Summer institute training should be supplemented with follow-up training during the school year. And, to insure system-wide adoption of the new curriculum as well as to maximize the opportunities for all teachers to acquire essential skills and strategies for mathematics instruction, training may need to

be viewed as a multi-year offering. Additionally, MCPS will need to provide ongoing supplementary training to meet the needs of new teachers who will be hired in the future.

Recommendation 3: If quarterly or end-of-unit assessments will continue to be used to support mathematics instruction, further development needs to take place on the assessment items. Validity and reliability checks need to be conducted, and teachers need to have a sense of the level of performance on the assessments that indicates students' acceptable mastery of the objectives. Training will probably be needed to provide teachers with a complete understanding of the different performance levels that their students might attain, and how best to interpret these performance levels as they plan subsequent instruction for the students.

Recommendation 4: Although students in upper elementary grades appear not to have been adversely affected by being thrust in the Singapore curriculum, implementation would have been easier and more palatable for teachers and parents if the curriculum were implemented incrementally, starting with the primary grades initially and then moving to the upper grades. MCPS is already moving in this direction by beginning system-wide implementation of new curricula in Grades 1 and 2.

Recommendation 5: Since the principal's involvement and leadership is critical to the successful implementation of curriculum reform, principals should be formally included and given a voice in the decision-making process for future reform efforts. Perhaps the principals and other key staff in Schools 1 and 2 could serve as consultants to MCPS curriculum staff on strategies for including principals in the future. They also could provide valuable information to their colleagues regarding how they used their instructional leadership skills to make positive change happen in their schools.

Recommendation 6: Careful consideration should be devoted to effective ways of building parent knowledge and obtaining their support of future curriculum efforts. Also, school staff need information packets and a variety of resources (such as sample agendas and personnel they could invite to their schools to assist with information meetings) that they could use in working with their communities.

Recommendation 7: The principals of the four Singapore pilot schools tried various ways of supporting mathematics instruction. One of the schools had a full-time mathematics specialist. One school reallocated the teacher/student ratio to free up a half-time position to support mathematics. In this school the half-time person was used, in part, to provide parent outreach. In the other two pilot schools part of the staff development teacher's responsibilities was to support teachers in mathematics instruction.

To assist the Title I schools in implementation of the new mathematics curricula, each school will have a half-time mathematics specialist. We recommend that MCPS collect data regarding how these specialists spend their time, and examine which aspects of the support they provide to teachers appear to be most useful and effective.

Appendix

Data Activities and Respondent Groups for the Evaluation Study

Data Activity	Singapore Pilot Schools	Control A Schools	Control B Schools
Classroom observations	62	32 *	0 **
Teacher surveys	63	37 *	0 **
Principal interviews	4	2 *	0 **
Student focus groups (# groups)	4	0 *	0 **
Student focus groups (# students)	84	0 *	0 **
Parent focus groups (# groups)	4	0 *	0 **
Parent focus groups (# parents)	34	0 *	0 **
Quarterly assessments	1,660	1,447 ***	0 **
Analysis of report cards, CTBS, CRTs, MSPAP, and prior ISM performance	1,593	1,413	1,491

* Of the four Control A schools that agreed to participate in the study, two were only interested in using the proposed quarterly assessments in place of ISM assessments. These schools were not interested in participating in any teacher training, thus they were not included in some aspects of data collection for the evaluation study.

** Since the Control B schools did not actively participate in the evaluation study, they were included in only the analysis of report card and mathematics assessment data.

*** None of the Control A schools participated in the first quarterly assessment; 3 participated during 2nd quarter, and all 4 participated in quarters 3 and 4.

Description of the Restructuring of Mathematics Instruction in School 1

The principal of School 1 used her leadership ability to completely restructure how the school would be organized to deliver mathematics instruction and how teachers would be supported to teach mathematics. This restructuring included:

- abandoning homogeneous (ability) grouping in mathematics, in favor of heterogeneous grouping – no longer was there a "low" class and a "high" class in mathematics; rather, each class in a grade level had students with a diverse range of abilities in mathematics.

- slightly increasing class size to free up a full-time teaching position which was divided between a half-time teacher to support reading instruction and a half-time teacher to support math.

- emphasizing staff development – nearly all of the school's staff development money was devoted to supporting Singapore Math, and nearly all the school's instructional supplies money was used to purchase materials to support the Singapore curriculum.

- physically locating teachers within grade levels in adjacent classrooms – this enabled teachers to debrief in the hallway following math class, check students' progress in the math curriculum on a daily basis, and, as a team, make adjustments to the next day's lesson.

- providing common planning time for teachers within a grade level.

These factors, combined, enabled the teachers in School 1 to pull together as a professional learning community in which they worked together to plan for and implement effective mathematics instruction. This is most notable in the perceptual shift expressed by teachers in School 1 regarding the relative benefits of homogeneous vs. heterogeneous grouping for mathematics instruction. When the principal reorganized mathematics classes to make them heterogeneously grouped for instruction, the teachers vocally opposed this move. By the end of the school year the teachers had changed their minds; 86 percent strongly disagreed with the concept that students generally learned mathematics best in classes with students of similar abilities.

Finally, when the evaluation team visited schools to observe classroom instruction, they learned that the teachers in School 1 planned a week's worth of lessons together in grade level teams and taught these lessons to all their classes. Often these planning sessions took place on the weekends – yet another example of the culture shift in this school.