Evaluation of the School of One Summer Pilot:

An Experiment in Individualized Instruction

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Executive Summary

The School of One pilot project is a research and development program launched by the New York City Department of Education, with the goal of providing students with individualized instruction by bringing digital technologies to bear on three core activities—identifying individual student learning needs, identifying unique resources to meet those needs, and scheduling individualized instruction. The School of One development team hopes to create an approach that reorganizes the typical classroom, using technology to support new and different roles for teachers, students, and administrators to give students the content and instructional support they need when they need it.

The nerve center of the School of One instructional model is the Learning Algorithm being designed by program staff and outside consultants from Microsoft and Wireless Generation. The Algorithm is a database-driven system that tracks student progress; combines that data with students' learning profiles, their learning needs, and the available instructional resources; and then schedules the next day's activities for each student. In the standard model of teaching, subject teachers prepare their own whole-class lesson plans for the next day's scheduled classes; whereas, in the School of One model, scheduling is both individualized and centralized. Each student receives his or her own unique schedule each morning, consisting of the skills he or she has been diagnosed as needing to learn.

The Education Development Center, Inc.'s, Center for Children and Technology (EDC/CCT) was asked to evaluate the pilot. Because the School of One approach is still in early development, the leadership of the School of One development team asked the evaluation to focus on two questions:

- Is this a potentially effective learning model? How do students move through the content? Are there positive learning outcomes?
- Is this a logistically feasible model? What are the experiences and logistics of the implementation for students and teachers?

EDC/CCT used two types of data for the evaluation: (1) qualitative data collected through interviews and observations conducted by EDC/CCT researchers and math education experts and (2) quantitative data on student progress through course materials generated by the School of One program.

Though the pilot was a summer program, it provides valuable insight into the basic nature of the approach and can inform the design of a program that will fit into the regular school-year calendar. The summer program is different from the school year in that most of the content was a review of previously learned material; most students volunteered and were doing well in math; and the pilot was housed in one large space. However, the pilot begins to answer some of the challenging questions generated by an innovation such as this regarding logistics and the learning process. It also identifies pressure points where the model can be improved and enriched.

Learning Outcomes

Table 1: Percent of items correct on pre- and post-tests (for students tested on 10 or more skills)

	N	Mean	Std. Deviation
Total percent correct on pretest	75	41.6%	14.8
Total percent correct on post -test	75	69.8%	15.5
Increase in percent of items correct	75	28.2%	16.4

How did students do on the pre- and post-tests?

Overall, the students in the pilot improved their math performance on the post-tests when looked at from two ways. First, in School of One, all students were tested on a different number of skills and on different skills. For consistency, EDC/CCT calculated the percent of items correct from the total number of items on each student's test. These data indicate that the pilot students posted an average increase of 28 percent in the number of test items correct (see Table 1). The mean percent of items correct went from 42 percent on the pretest to 70 percent on the post-test – an increase of 28%.

Additionally, the data can be broken down to see how many skills students were able to master. The data on mastery show that students mastered (55 percent) and improved on (19 percent) many of the skills they attempted. These findings suggest that the School of One approach can increase students' math achievement (see Table 2).

Table 2: Student Change in Math Skills (mean skills per student n=783)

	Mean	Percent
Number of skills attempted	9.6	100%
Number of skills mastered	5.3	55%
Number of skills with gains, but not mastered	1.8	19%
Number of skills with no movement	1.7	17.5%
Number of skills showing regress	.78	8%

Can the School of One model develop mechanisms to ensure slower moving students cover a minimum set of skills each year?

In School of One, students moved through the material at their own pace. Students covered a mean of 9.7 skills, but there was some variation with the Level 2 students who covered one skill less. The pilot was an intensive program of four hours a day, so the variation in pace may change during a standard school year, increasing the distance between students.

How can the School of One model address issues in measuring student knowledge and abilities in ways that can support instructional decision-making?

Although School of One has made great strides in creating an algorithm that makes mass differentiation feasible, the process of benchmarking student knowledge or diagnosing students' instructional needs is a complex task.[1]

How can the School of One model ensure that students have opportunities to build conceptual and critical understanding of content?

As a summer program, the pilot focused primarily on developing students' operational knowledge of math. Developing students' broader conceptual mathematical understanding was a concern for the teachers and educators in the program.

Learning process

The pilot of School of One was also an opportunity to begin understanding how this type of differentiation may affect the learning environment and the learning process. The pilot experience highlighted a number of dimensions of teaching and learning that changed when students changed teachers, resources, peers, and skills at every lesson.

What are teachers' and students' overall impressions of their experience with School of One?

The results of surveys administered by School of One to teachers and students echoed their comments during interviews. All but one teacher agreed that the program had a positive impact on students' math skills. According to one teacher, "[the] individual focus on students really seems to show a significant improvement in mathematical abilities as well as motivation." The majority of respondents also felt that School of One had the potential to transform the way that instruction is individualized in New York City public schools, and that such a program could be particularly helpful for students who struggle in traditional classrooms.

The students also had extremely positive feedback: Nearly 80 percent reported that they liked going to School of One, and virtually all students appreciated having a schedule that changed every day. According to one student, "One of my favorite things about School of One is that everything is different, unlike regular school, and everyone is doing something different every day."

[1] Pellegrino, J., Baxter, G. et al. (1999). Addressing the "two disciplines" problem: Linking theories of cognition and learning with assessment and instructional practice. *Review of Research in Education* 24: 307–353.

What are the new pedagogical approaches needed for the School of One model?

The School of One approach creates a demand for teaching strategies and pedagogical approaches to support individual learners that teachers typically would not use in a "whole-class" environment, and with which they may be less familiar. Some teachers found the proctoring strategies and one-on-one approaches initially challenging—it is harder to monitor a number of students working on widely ranging skills and using different materials than when all students are on the same skill and the same set of instructional resources. Plus, the types of strategies needed to push students working individually to reflect or deepen their thinking are different than the collaborative and project-based approaches.

How can School of One promote the development of meaningful student-teacher relationships?

The School of One approach represents a change in teacher-student relationships, moving away from one teacher tracking and supporting one student's overall development in math to relationships with multiple teachers for each student, where different teachers may help students with the same skill during different lessons. Especially with struggling students, teachers often leverage their prior knowledge of a student's strengths, weaknesses, or personal understanding of math concepts to introduce new concepts or correct misconceptions.

Can the School of One model provide students with a larger range of social learning experiences?

The pilot of School of One also changed students' social experience of learning so that most of the learning happened in individual contexts. Most of the scheduled activities had students learning on their own, with few project activities, and none that lasted longer than 40 minutes. When teachers had small- or large-group instruction, all activities had to end within the 40-minute lesson period. One clear group activity was the video game that the students enjoyed playing.

How does School of One weave a coherent curricular sequence for each student?

The School of One approach represents a change in the relationship between learners and instructional resources. In a traditional math classroom, there is typically a curricular framework that provides a coherent path through the material to support learning, and the coherent path is more than just a sequence of skills. A strong curricular framework has some strengths that math educators highly value, which the pilot teachers attempted to replicate since they found them missing in the pilot experience. A few of the relevant features of a core curricula process are a common vocabulary to enable conversations about math, periodic reviews, and repeated problem sets; it can also gradually expose students to increasing difficulty or complexity within the same skill; and, it can provide a larger conceptual understanding of math. In School of One, each student may use different resources from lesson

to lesson that present the material from different perspectives, but the resources may also use different vocabulary or techniques. In the current version, the Learning Algorithm uses a learning progression of discrete skills to create a linear sequence of activities. For example, the Algorithm does not loop students back to skills or schedule refreshers, nor does it purposely schedule students to introductory and then complex levels on a single skill.

Logistics

The findings from the pilot suggest that the Learning Algorithm—although still in development—easily created individual daily schedules for the students and teachers of School of One. The data suggest that daily schedules afforded all students a diversity of instructional modalities and resources, and no group or category of student was concentrated in one type of resource or modality. The Algorithm was able to create a learning environment where every student was engaged with different activities and skills throughout the day, and no two students had the same schedule.

How did the School of One pilot smooth out traffic flow issues?

There were a number of important factors to the smooth flow of students and teachers around the learning spaces during the pilot. The design of the learning space, the clear rules of behavior, and the television monitors and floor manager helped to create a quiet and orderly environment, where neither students nor teachers were lost, and the noise level was not a distraction. Also, the program tries to match the content to students' skill level and prior knowledge. The School of One team played important roles behind the scenes, undertaking part of the planning and preparation work for the teachers. The team was able to prepare and stage the lessons effectively so that the teachers were able to start teaching the assigned lessons each morning without delay or having to arrange materials themselves.

What are the important social aspects underlying the smooth logistics in the School of One model?

Two important factors in making the pilot so logistically smooth were the social dynamics and the focus of the students who participated in School of One. The students were given clear expectations for behavior, and the adults consistently reinforced the same message. Most of the students were from the same middle school in Chinatown, so many of them knew each other and got along well as a group. Most of the students were Level 3 and 4 and generally successful in math. Throughout the program, they were generally focused on their computers or on the task at hand. Even after four hours of math, they were still well-behaved and energetic for the daily assessment at the end of the class.

Recommendations

The tremendous flexibility of the School of One approach suggests many paths for further development of this model. As the School of One team moves from a summer program to a typical school setting, they will need to capitalize on that flexibility to meet the challenging requirements and constraints of that context. The Learning Algorithm can work with many types of assessment data, instructional resources, and modalities. The School of One team should take advantage of this strength to explore ways to incorporate an even greater range of content, assessments, and instructional models. The team might want to consider the following issues:

- Pacing for slower students: Learning Algorithm does not include each student's pace as a variable in scheduling instruction in way that might direct slower moving students to strategies to move them along faster;
- Conceptual understanding of math: explore strategies to address the broader conceptual context of math;
- Curricular sequencing: consider ways to allow spiraling content and increasing complexity or difficulty of the materials;
- Social context of learning: consider increasing variety of instructional resources and modalities to include more projects and group work;
- Professional development: consider professional development around teaching strategies focused on working with students individually

Conclusion

The School of One approach is intended to transform three traditional processes concurrently—assessment, instruction, and scheduling—and thus represents a new model for how schools can function. The long-term validation of the model will require a focus on student learning outcomes, but, at this early stage, when many components of the process are tentative and open to revision (i.e., altering instructional resources, diagnostic techniques, and other aspects of the model), the evaluation focus was on the feasibility of the model, and whether it offers the potential for impact on student learning that warrants continued effort.

In response to both of those concerns, the pilot evaluation findings suggest that the core of School of One holds potential. Although there are a number of ways the approach can be refined and improved, the Learning Algorithm was able to produce daily schedules for teachers and students that kept students moving forward on their playlists. The learning environment created for the pilot also functioned smoothly, with minimal confusion among the students and teachers. The findings also suggest that the constant variation that students experienced did not keep them from mastering the targeted content, and the School of One program did help students improve their math performance.

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Introduction

The School of One pilot project is a research and development program launched by the New York City Department of Education, with the goal of providing students with individualized instruction. To accomplish this, School of One injects technology into many of the processes of schooling, including determining what, when, and how students are taught. By bringing digital technologies to bear on three core activities—identifying individual student learning needs, identifying unique resources to meet those needs, and scheduling individualized instruction—School of One team hopes to develop a process that will give students the content and instructional support they need when they need it. In doing so, the School of One approach seeks to reorganize the typical classroom, using technology to support new and different roles for teachers, students, and administrators.

Using the Learning Algorithm, which was designed by program staff and outside consultants from Microsoft and Wireless Generation, School of One piloted this new process for coordinating student learning in the summer of 2009 at a school in Chinatown with a five-hour summer program for sixth-grade students. This summer pilot was an initial step in developing the technological tools and processes required to realize the School of One vision.

The Education Development Center, Inc.'s, Center for Children and Technology (EDC/CCT) was asked to evaluate the pilot. Because the School of One approach is still in early development, the leadership of the School of One development team asked the evaluation to focus on two questions:

- Is this a potentially effective learning model? How do students move through the content? Are there positive learning outcomes?
- Is this a logistically feasible model? What are the experiences and logistics of the implementation for students and teachers?

School of One is innovating on three levels concurrently—assessment, instruction, and scheduling—and thus represents a potentially powerful new model for how schools function. For the long-term validation of the model, a focus on student learning outcomes will be important. But at this early stage, when many components of the process (instructional resources, diagnostic techniques, etc.) are tentative and open to revision, the primary concern is on the feasibility of the model and whether it offers the potential for impact on student learning that warrants continued efforts in the project.

The following report reviews the evaluation methodology, describes the components and resources used in the summer pilot, explains the Learning Algorithm, and presents data on both the students' progression through the School of One summer pilot program, and the teachers' and students' experiences in the program.

Methodology

EDC/CCT's evaluation used two types of data: (1) qualitative data from interviews and observations conducted by EDC/CCT researchers and (2) quantitative data on student progress through course materials generated by the School of One program. Over the 20 days of the pilot, researchers observed more than 30 hours of class time and conducted formal and informal interviews with all of the teachers, teaching residents, school administrators, and most of the School of One project team. Throughout the program, researchers also interviewed students regarding the activities and the School of One experience. EDC/CCT also consulted with its own math educators and sent two math education experts to visit the pilot as well as to offer feedback on School of One as an approach to math education.

The School of One process also generated a substantial amount of data about itself. The School of One team provided EDC/CCT with the students' daily schedules, assessment results, diagnostic results, learning profiles, pre- and post-test data, and data on the instructional resources used. These data were analyzed to understand the students' progression, their learning outcomes, and the resource distribution. School of One also surveyed the participating educators and shared that data as well.

School of One Pilot

This section describes the components used in the summer pilot of School of One. School of One used instructional resources that were either available to New York City school teachers at the time or were donated for the School Of One pilot. Because of the flexibility of the approach and the technological process being developed, many of the components that were used in the pilot (e.g., the instructional resources, the daily assessments) may be changed or replaced with other inputs in future instantiations. This section briefly outlines the following components of School of One: learning progression, benchmarks and daily assessments, instructional modalities, and instructional resources. The core of the School of One instructional model, however, is the Learning Algorithm (detailed in the following section), a complex, automated scheduling tool that brings the above components together to give each student the right content, at the right time, and in the right instructional modality.

Learning Sequence

The learning progression establishes the sequence in which skills or topics are taught in School of One. The School of One team adapted their learning progression from the New York State Performance Indicators (PIs)[1] for fifth-grade, sixth-grade, and seventh-grade

[1] See http://www.emsc.nysed.gov/nysatl/standards.html

math. From the entire list of PIs, the School of One team selected 77 PIs to cover the learning progression for the summer pilot and the sequence flows from the order in which the skills were organized by New York State (see Appendix A).

Benchmarks and Assessments

Benchmarks: To identify the students' learning needs, the School of One team used existing test results where possible or administered a separate test for those skills that were not included in the preexisting data. From the resultant data, School of One created for each student a list of the skills on the Learning Progression that the student had not passed. From this individual list, the School of One created a "playlist" of the first 15 skills the student needed to improve (see Appendix B).

Daily Progress Assessments: To monitor student progress on each PI, the program assessed each student at the end of every day on the skill (or skills) on which they had worked that day. School of One used McGraw Hill's Acuity™, a suite of online assessments for math, as part of the assessment and combined it with open-ended questions developed by the School of One team, which the students answered on paper.

Assessing Mastery: To measure change in student math performance, School of One administered pretests and post-tests. The pre- and post-tests were also built from the Acuity™ database. Most students were given a pretest on up to 15 of their identified skills prior to the start of School of One and were tested again on those same skills at the end of the program.

Instructional Modalities

During the pilot, the School of One approach used eight instructional modalities or delivery methods ranging from teacher-based instruction to virtual instruction to individual work with pencil and paper. The eight modalities were Teacher-Led Instruction, Teacher-Led Practice, In-School Tutoring, Individual Practice, Virtual Instruction, Virtual Practice, Virtual Tutoring, and Video Games.

Instructional Resources

The School of One approach incorporated lessons from five categories of instructional resources (for the pilot, a "lesson" was an instructional resource, such as a chapter, worksheet, webpage, learning activity, or set of activities that targeted a specific PI and could be completed in 40 minutes).

Textbook resources: School of One used materials from pre-existing math curricula that were commonly available in New York City at the time of the pilot: Connected Mathematics Project (Connected Math), Everyday Math, and Impact.

Teacher-made lessons: Each of the four School of One teachers was responsible for teaching a subset of 18 to 20 of the 77 total skills. Prior to the launch of the pilot, the teachers created collections of lesson plans to use during the program on their assigned skills.

Website resources: Students scheduled for virtual instruction or reinforcement worked with one of four websites: MathScore® and MathXL, which provided multiple problem sets; Study Island, which provided similarly structured problem sets, but incorporated simple arcade style games; and Destination Math, a multimedia platform in which an alien character, "Digit," guided students through both cyber-lessons and cyber-practice. Each program's content could be customized, resulting in problem sets and instructions geared to specific skills covered in the School of One curriculum.

Virtual tutors: School of One contracted with Educate Online, an online tutoring service, to work with up to 10 students per instructional period. A student scheduled for Educate Online worked on one of the Virtual Tutoring designated computers, equipped with a headset and microphone so that the student could interact with the online tutor.

Video Game: Tabula Digita, an educational gaming company, provided the School of One with DimensionM, a multi-player, math-based computer game.

The Learning Algorithm and Scheduling

The nerve center of the School of One instructional model is the Learning Algorithm, a database-driven system that tracks student progress; combines that data with students' learning profiles, their learning needs, and the available instructional resources; and then schedules the next day's activities for each student. In the standard model of teaching, subject teachers prepare their own whole-class lesson plans for the next day's scheduled classes; whereas, in the School of One model, scheduling is both individualized and centralized. Each student receives his or her own unique schedule each morning, consisting of the skills he or she has been diagnosed as needing to learn. Teachers receive their schedules the night before.

Briefly, the Learning Algorithm—which is still in development—pulls information from a number of databases containing student benchmark data; ongoing student assessment data; student learning preferences (identified using the survey from the Renzulli Learning System[2]); and data on available lessons and instructional resources (including space, teacher availability, etc.) to create a schedule that provides each student with "what they need, when they need, and how they need it." While the goal of the School of One program is to fully automate and individualize the daily scheduling process, human intervention in the process

[2] See http://www.renzullilearning.com

was required to run a functioning pilot program. During the pilot, consultants from two of the program's partners, Wireless Generation, Inc., and Microsoft, worked to develop the automated process. Part of their work consisted of doing manually what the algorithm was not yet capable of doing.

Once the schedules were generated, four to five program staff members organized the next day's materials for each instructional period, including programming each virtual resource for each student during each instructional period.

Overall, the School of One scheduling process took up to five hours to complete each day for much of the program staff.

A Typical Day at School of One

To help the reader envision the ways in which the School of One approach changes the learning environment, this section provides a brief description of a typical day for a student at School of One, using data compiled from 30 hours of observation by EDC/CCT researchers.

The School of One summer pilot program took place in the school library. The room was divided into five main sections—named after the five boroughs (see Figure 1). Bookshelves were used as walls to separate each section of the room; flat screen televisions (displaying student schedules and location assignments) were set up at key points around the room.

During school hours, at least six educators, three program staff, and two interns were in or around the room. Another important component of School of One was the technical support available from the School of One project team. They were located next door to the library and easily contacted if teachers encoun-

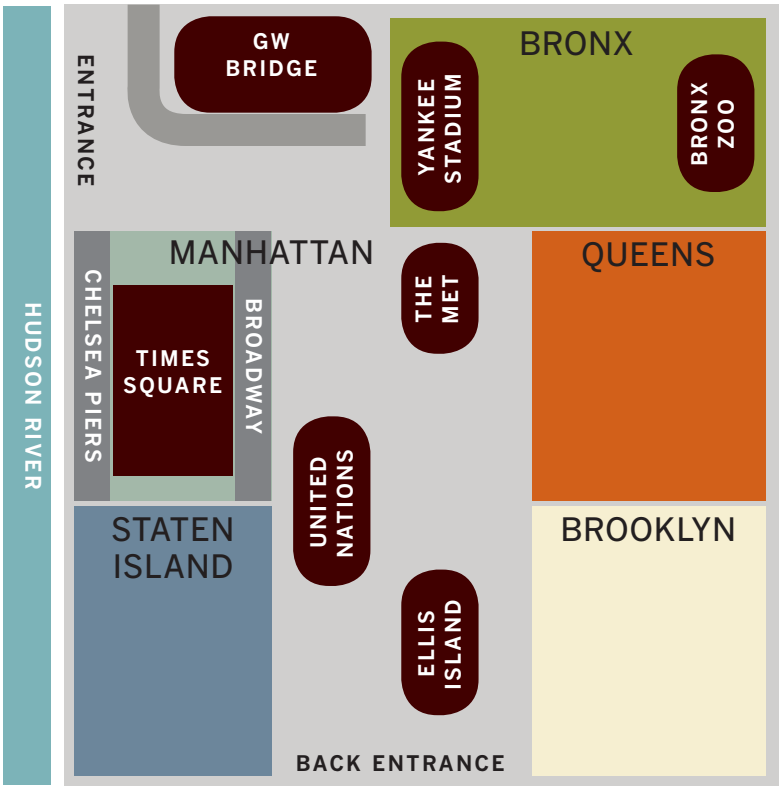


Figure 1 Layout of the School of One learning space

tered technical problems beyond their skill level. A high school intern, who helped collect the laptops, also provided technical assistance.

The school day starts at 8:30 a.m. Students arrive, pick up their laptops and personal folders (containing their daily schedule, shown in Figure 2) from the appropriate cart, and bring them into the School of One room, where they sit with their homeroom/team to hear the School of One floor manager give morning announcements. Generally, a few School of One staff are stationed by the entrance to help orient students. After announcements, students go to the first of four 40-minute instructional periods. Each student's folder has a printed copy of his or her daily schedule, telling them where to be for each period and what lesson they will be doing. Additionally, the flat screen televisions hung around the room display the schedule of the current instructional period by area.

Figure 2 School of One daily schedule

Sessions	Time
Breakfast/Laptop Pickup	8:00–8:30
Homeroom	8:30–8:37
Session 1	8:40–9:20
Lesson 2	9:23–10:03
Break	10:03–10:40
Lesson 3	10:43–11:23
Lesson 4	11:26–12:06
Playlist Update	12:10–12:30
Check-Out	12:30–12:40

For each instructional period, students are sent to one of the sections of the School of One room. Each section is designated for a different instructional modality. The Brooklyn and Staten Island sections are set up to allow teachers to work with large groups of students, or it can easily be rearranged for teaching residents to support students working individually on their laptops with online resources (described below). Queens is set up for large-group instruction, with two long tables and a smart board, or the room can be split in two for concurrent large-group lessons. In the areas designated as Bronx, Ellis Island, The Met, and the United Nations, teachers and teaching residents work with students in small-group instruction. In Manhattan, at Times Square, students work with virtual tools, workbooks, and sometimes one-on-one with a teacher. At Broadway, there are 10 spots for students to access Virtual Online Tutoring.

During the instructional periods, teachers and teaching residents teach either small- or large-group lessons or proctor students as they work with virtual tools on their laptops. Small- or large-group lessons consist of students all working with one teacher on the same skill, with the teacher having the discretion to decide what materials or activities to use to accomplish the task.

During virtual instruction, teachers or residents proctor the sessions as students use the tools and work on the activities selected by the Learning Algorithm. The proctor has a list of the students he or she will be supporting, along with what skill each student is working on and which virtual tool each student is using. Teachers float around the class, checking to see how students are doing and offering help as needed. Some teachers group students working on the same skill, so that, if need be, they can provide some just-in-time small-group instruction to a subset of students.

Teachers commented that many students in the virtual instruction or practice sessions finished early. Students have a number of options once they finish their assignments in the virtual tools, such as play the math games embedded within some of the virtual tools or read a book until the end of the instructional period. However, if the proctoring teacher felt a student needed more practice, he or she would ask the student to continue working with that tool to practice the skill again.

Five minutes before the end of each instructional period, the floor manager gives every section a five-minute warning. At the conclusion of the period, the floor manager announces that it is time for students to transition to their next instructional period. After the first two instructional periods, students have recess, before which they return their laptops and folders to the appropriate cart, to be picked up before the beginning of the third instructional period.

Recess is also the time when students have their weekly advisory sessions with a teacher. During the recess period, a number of students (three to four per day) are scheduled for advisory; during which time, they each sit with a teacher or School of One staff member to check in and discuss any problems they might be having.

At the end of the fourth instructional period, students return to their homeroom areas and complete their individualized playlist update (end of day assessment), which consists of six multiple-choice questions that they answer in Acuity (an online assessment site) on their laptops, and two long-answer questions that they answer on paper. Upon finishing their assessment, each student returns his or her laptop and folder to the cart and leaves for the day.

Participating Students and Educators in the School of One Pilot

Who were the students who participated in the School of One pilot?

The School of One pilot was a five-week summer program held at a middle school in Chinatown, with 80 soon-to-be seventh-grade students attending four mornings a week for five hours a day. All sixth-grade students were invited and the participants were mostly volunteers, with only two students from another school mandated to take summer school.

The student population was largely male and Asian American (see Table 1). Most of the students were performing at or above grade level (Levels 3 and 4) in math, as indicated by their performance on the New York State math test (see Table 2a). Only six students were in Level 2, which indicates that they performed below grade level on the test. None of the students were in Level 1. There was also a sizable portion of students who were English Language Learners (ELL) and who had Individualized Educational Plans (IEP) (see Tables 2b and 2c).

Table 1: School of One student population demographics

By Gender		**By ethnicity**	
Girls	27	Asian	72
Boys	53	Hispanic	4
		African American	3
Total	80	Total	79

Table 2a: School of One student population academic characteristics

By New York State Performance level	
Level 1	0
Level 2	6
Level 3	46
Level 4	21
Total	73

(Table 2a: 7 students have missing data)

Table 2b: School of One student population academic characteristics

By IEP Status	
Non-IEP	58
IEP	22
Total	80

Table 2c: School of One student population academic characteristics

By ELL Status	
Non-ELL	58
ELL	21
Total	79

(Table 2c: 1 student has missing data)

Who were the educators who participated in the School of One pilot?

The educators for the pilot consisted of four teachers,[3] four teaching residents, one math specialist, three high school interns, and one floor manager (a person who coordinated the teachers and maintained student discipline). Of the educators, eight were women and two were men; of the high school interns, two were girls and one was a boy. Of the teachers, three teachers were from the pilot school, and one teacher was from a school in Queens. Two were veteran teachers with more than five years of classroom experience, and two were in their second year of teaching. The four teaching residents were from the New York University Math for America (MFA) program. Although all the residents had strong math backgrounds, none of them had previously taught in K–12 classrooms. The math specialist was a veteran math educator, also from the pilot school in Chinatown. The floor manager was an assistant principal from a school in the Bronx.

What skills did students need to work on during the pilot?

To identify the students' learning needs, the School of One team used pre-existing test results where possible or administered a separate test for skills that were not included in the pre-existing data. The School of One team conducted an item-by-item skills analysis of the students' results on the fifth- and sixth-grade standardized exams to identify student needs on approximately 50 of the 77 PIs. The remaining PIs were benchmarked by tests compiled by the School of One team.

From these data, School of One created a list for each student of the skills on the Learning Progression that the student had not passed. From this individual list, the School of One created a playlist of the first 15 skills the student needed to improve.

After the benchmarking process, 72 of the 77 PIs were represented across the combined playlists. Over half of the need (56 percent) was on sixth-grade skills, with 17 percent on fifth-grade skills and 26 percent on seventh-grade skills (see Table 3). Students needed to improve on some PIs more than others. The five most frequently needed skills, for example, were all sixth-grade skills. For example, 69 students were diagnosed as needing help with sixth-grade performance indicator *6.N.03: Define and identify the distributive property of multiplication over addition* (see Chart 1).

Table 3: Percent of students' needs by Performance Indicator grade level

	Percent
5th-grade PI	17.2
6th-grade PI	56.2
7th-grade PI	26.6
Total	100

[3] Although, one teacher started a week late, and another teacher substituted for him during the first week of the program.

Chart 1: List of the five most common Performance Indicators (PIs)

Performance Indicators	Name	Students diagnosed for this PI
6.N.03	Define and identify the distributive property of multiplication over addition	69
6.N.02	Define and identify the commutative and associative properties of addition and multiplication	66
6.N.04	Define and identify the identity and inverse properties of addition and multiplication	62
6.A.01	Translate two step verbal expressions into algebraic expressions	61
6.G.07	Determine the area and circumference of a circle using the appropriate formula	55

Student progression through the content and learning outcomes

The School of One pilot produced a large amount of data from a range of sources, including students' daily schedules, assessment results, diagnostic results, learning profiles, and pre- and post-test data, in addition to data on the instructional resources used. EDC/CCT analyzed these data to understand student progression, resource distribution, and learning outcomes. This section presents these data.

How many skills did students work on during the pilot?

Because pacing is an important aspect of the School of One approach, EDC/CCT examined how students moved through the skills.

The School of One model individualizes pacing—students must master a skill before they move on to the next skill on their playlist (unless they have made 8 number of attempts). Although all students started with 15 skills on their playlist, students went through different numbers of skills. Some students progressed faster and covered more than 15 skills; however, most students did not move beyond their first playlist.

On average, students attempted 9.6 skills during the program (see Table 4). When examined by student's math proficiency level, the average number of skills attempted ranged from 8.7 skills for the Level 2 students to 9.7 for the Level 4 students. The average number of skills attempted does not vary noticeably by ELL or IEP status.

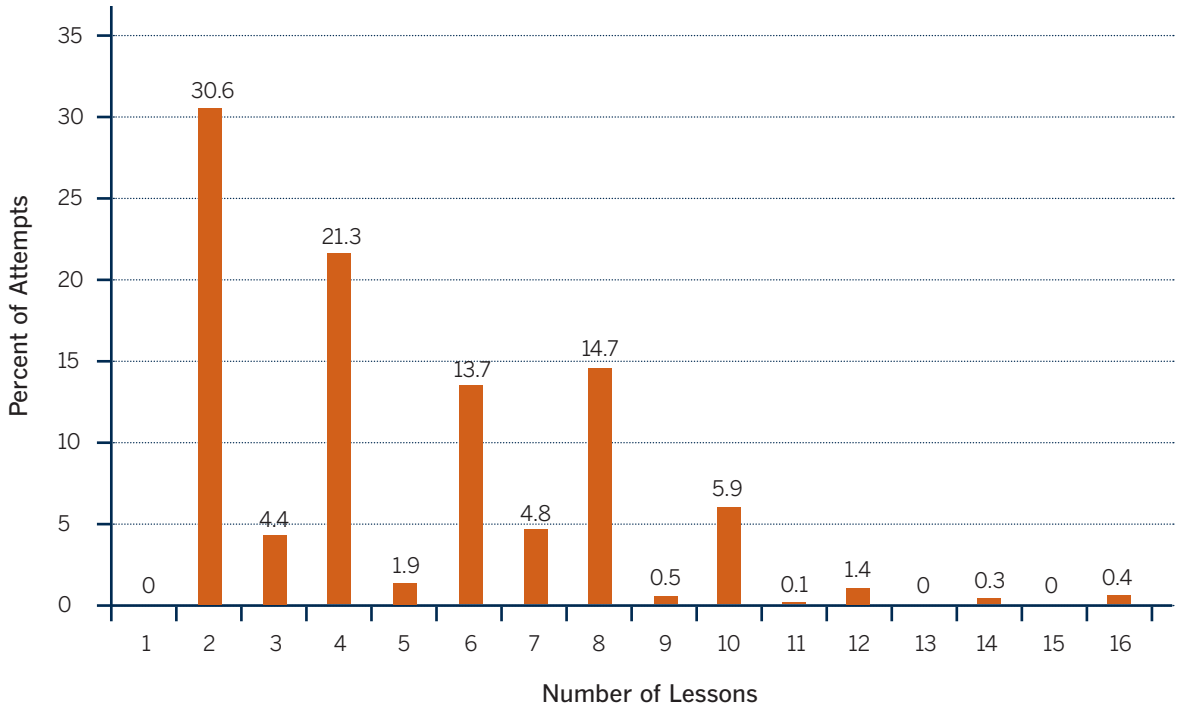
Table 4: School of One students' mean number of skills mastered by achievement level, IEP status, and ELL status

	Mean # of skills attempted	Mean # of lessons
Achievement level (N=73)		
Level 1 (N=0)	-	-
Level 2 (N=6)	8.7	5.9
Level 3 (N=46)	9.6	4.9
Level 4 (N=21)	9.7	4.5
Total	9.6	4.9
IEP status (N=75)		
IEP (N=15)	9.3	5.5
Non-IEP (N=60)	9.6	4.7
Total	9.6	4.9
ELL Status (N=75)		
ELL (N=21)	9.9	4.8
Non-ELL (N=54)	9.4	4.9
Total	9.6	4.9
Grand Mean (N=75)	9.6	4.9

How many lessons did students require on each skill?

The scheduling data from the pilot tracked the number of lessons assigned to each student for each skill. Overall, students received an average of 4.9 lessons (196 minutes of instructional time) before they "mastered" a skill. It should be noted, however, that there was a wide range in the number of lessons per skill. On 31 percent of the attempts, students progressed after two lessons. The School of One team eventually decided to progress students after eight lessons. But in the first six day of the program, a few students took as many as 16 lessons to pass the daily assessment (see Figure 3).

Figure 3: Percentage of completed attempts by the number of lessons it took to master the skill



The data can also be broken down by the grade level of the skill (see Table 5), which suggests that students who needed to review fifth-grade skills spent more time on those skills, than students reviewing sixth or seventh-grade skills. Data indicate that students took the longest on fifth-grade skills with a mean of 6.3 lessons on each skill, and moved the fastest on seventh-grade skills at 4.0 lessons per skill.

Table 5. Number of lessons per Performance Indicator

Indicators by PI grade level	Mean number of lessons per PI
5th grade (22 PIs)	6.3
6th grade (29 PIs)	4.6
7th grade (23 PIs)	4.0

What instructional modalities were used during the pilot?

During the pilot, the School of One used eight instructional modalities or delivery methods, ranging from teacher-based instruction to virtual instruction to individual work with pencil and paper (see Table 6). The two most common modalities were virtual practice (23 percent) and teacher-led instruction (21 percent), followed by virtual instruction (19 percent). Together these three formats accounted for 63 percent of total instructed lessons. Video games were the least commonly used instructional delivery method, accounting for only 2 percent of all lessons, but this may be because there was only one video game resource in the pilot and it targeted only some of the PIs.

Table 6. Distribution of lessons by instructional modality	
Teacher-led instruction	**21%**
Teacher-led practice	7%
In-school tutoring	4%
Individual practice	13%
Virtual instruction	19%
Virtual practice	**23%**
Virtual tutoring	10%
Video games	2%

What instructional resources were used during the pilot?

The School of One pilot included lessons from five categories of instructional resources. The scheduling data indicate that 4,490 lessons were scheduled (see Table 7). Overall, teacher-made lessons were the most frequently used resource, Destination Math was the most frequently scheduled website, and Impact Math was the most commonly used paper-based resource.

Table 7. Distribution of lessons by product type		
Product	**Number of lessons**	**Percent**
	Textbooks	
Impact Math	553	12%
Math Force	76	2%
Connected Math	47	1%
Everyday Math	51	1%
	Websites	
Destination Math	850	19%
Math Score	368	8%
Math XL	349	8%
Study Island	308	7%
	Virtual Tutoring	
Educate Online	442	10%
Game		
Tabula Digita	102	2%
	Teacher-made	
Teacher-made lessons	1,137	25%
Independent Practice	207	5%
Total	4,490	100%

How did School of One allocate instructional resources across the different instructional modalities?

The School of One data allow EDC/CCT to examine another aspect of School of One—allocation of instructional resources, time, and delivery methods to meet student needs. School of One provided students with a diverse mix of instructional delivery methods (see Appendix C). The scheduling of these resources was driven by the Learning Algorithm.

The data reveal noticeable differences in how the different modalities were used to support students at different achievement levels. With only six Level 2 students in the pilot, the data are not representative of the city schools' population but may be suggestive of how the Learning Algorithm directs resources to different populations.

Table 8 shows the distribution of modalities for each of the different math achievement levels. The students at Level 2—who were performing below grade-level—were in virtual practice for 29 percent of their instructional time, and they also had the highest proportion of in-school tutoring (5.2 percent of their lessons) and the second highest proportion of virtual tutoring (10.6 percent). The Level 2 students had the least amount of large-group, teacher-led instruction. This pattern suggests that the Learning Algorithm moves these students more quickly onto practice and reinforcement to build skills and, then, to one-on-one instruction if they require it.

The data suggest that the Learning Algorithm not only apportions resources differently to higher end and middle-range students, but it is sensitive to the number of students needing a skill. For example, the Level 4 students received more virtual instruction and tutoring than other students, but the School of One team felt the virtual tutoring was able to easily provide challenging content to the higher performing students when only one or two students needed that level of content that day. The Level 3 students, who were the largest group of students, had the largest proportion of teacher-led lessons, both for instruction (24 percent) and practice (8 percent).

Table 8. Distribution of instructional delivery methods by students' math achievement level (N=73)

Achievement level	Teacher-led instruction	Teacher-led practice	In-school tutoring	Individual practice	Virtual instruction	Virtual practice	Virtual tutoring	Video games
Level 1 (N=0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Level 2 (N=6)	15.2%	4.9%	5.2%	13.2%	19.3%	29.2%	10.6%	2.3%
Level 3 (N=46)	23.5%	8.1%	3.2%	11.9%	18.8%	23.2%	8.8%	2.4%
Level 4 (N=21)	17.7%	7.0%	4.0%	15.7%	20.1%	22.3%	11.5%	1.8%
Grand Mean (N=73)	21.1%	7.5%	3.6%	13.1%	19.2%	23.4%	9.7%	2.2%

The Learning Algorithm also apportioned resources differently based on the grade levels of the PIs, further demonstrating the differentiation made possible by School of One (see Table 9). The data indicate variation between the scheduling of teacher and virtual modalities between the fifth- and sixth-grade skills (skills students were reviewing) and the new material in the seventh-grade skills. For example, teacher-led instruction accounted for more than 20 percent of all lessons for both fifth- and sixth-grade skills. Teacher-led instruction for seventh-grade skills, however, was used in only 10.5 percent of lessons, but the seventh-grade skills had a higher proportion of virtual tutoring (14.8 percent). For these skills, a higher percent of lessons were delivered through virtual instruction.

There were also clear differences in the distribution of instructional time between fifth- and sixth-grade skills. Teacher-led practice was used much more often for sixth-grade skills than for both fifth- and seventh-grade skills. The opposite was true for the percent of lessons using virtual practice, which was lower for sixth-grade skills (19 percent) than for fifth- and seventh-grade skills (29 percent and 25 percent, respectively). This does not necessarily indicate that virtual practice is more effective than teacher-led practice for teaching fifth- and seventh-grade skills, only that the School of One approach enables teachers to have skill-appropriate resources for all students at all times.

Table 9. Distribution of instructional modality by Performance Indicator grade level

	Teacher-led instruction	Teacher-led practice	In-school tutoring	Individual practice	Virtual instruction	Virtual practice	Virtual tutoring	Video games
5th-grade PIs	23.9%	2.3%	4.7%	12.6%	16.3%	29.4%	8.9%	1.9%
6th-grade PIs	22.3%	11.7%	3.0%	12.5%	19.9%	18.9%	8.8%	2.9%
7th-grade PIs	10.5%	4.2%	3.6%	16.1%	25.1%	25.3%	14.8%	0.5%
Grand Mean	21.2%	7.4%	3.7%	13.0%	19.4%	23.4%	9.7%	2.2%

How many skills did the students master?

The data provided by School of One offer two ways to look at students' learning outcomes. One approach is to examine the number of skills each student was ultimately able to master an the other approach is to examine the post-test results. School of One considers that students have mastered a skill if they get all three daily assessment items on that skill correct. At the end of the pilot program, School of One measured student success on the post-test. Using the post-test data, EDC/CCT was able to examine the number of skills on which students were able to attain mastery.

Analysis of the post-test data reveals the following averages over the 80 hours of the program:

- Students attempted 9.6 skills
- Students mastered 5.3 skills (55 percent)
- Students gained on 1.8 skills (19 percent)
- Students showed no change on 1.7 skills (18 percent)
- Students declined on .78 skill (8 percent)

Since every student moved at his or her own pace, faster students were able to attempt more skills. The data indicate that the Level 4 students attempted 9.7 skills and the Level 2 students attempted 8.7. The mastery rate for the Level 4 students, at 66 percent, is the highest, and it is the lowest for Level 2 students, who mastered only 44 percent of skills measured on the post-test (see Table 10).

Considering that students only move on to the next skill if they pass the daily assessment or reach the maximum of 8 lessons on the topic, the lower percent of mastery among the Level 2 students may be worthy of further research.

Table 10: Average number of skills mastered per student by math achievement level

	Level 1 (N=0)	**Level 2 (N=6)**	**Level 3 (N=46)**	**Level 4 (N=21)**	**Totals (N=73)**
Mean # of skills mastered	-	3.8 (44%)	5.0 (52%)	6.4 (67%)	5.3 (55%)
Mean # of skills with gain, not mastered	-	1.8 (21%)	2.0 (21%)	1.3 (13%)	1.8 (19%)
Mean # of skills with no movement	-	2.0 (23%)	1.9 (19%)	1.3 (13%)	1.7 (18%)
Mean # of skills showing regress	-	1.0 (12%)	0.8 (8%)	0.7 (7%)	.78 (8%)
Mean # of skills attempted	-	8.7 (100%)	9.6 (100%)	9.7 (100%)	9.6 (100%)

Although the students with IEPs attempted the same number of skills as the rest of the cohort, at 44 percent mastery, they attained mastery in fewer skills than the non-IEP students (see Table 11). The mastery of the ELL students did not vary noticeably from the overall mean—53 percent mastery compared to 55 percent (see Table 12).

Table 11: Average number of skills mastered per student by IEP status			
	IEP (N=15)	**Non-IEP (N=60)**	**Total (N=75)**
Mean # of skills mastered	4.1 (44%)	5.6 (57%)	5.3 (55%)
Mean # of skills with gain, not mastered	2.2 (24%)	1.7 (18%)	1.8 (19%)
Mean # skills showing no movement	1.9 (20%)	1.7 (18%)	1.7 (18%)
Mean # of skills showing regress	1.1 (12%)	0.7 (7%)	0.8 (8%)
Mean # of skills attempted	9.3 (100%)	9.6 (100%)	9.6 (100%)

Table 12: Average Number of skills mastered per student by ELL status			
	ELL (N=21)	**Non-ELL (N=54)**	**Total (N=75)**
Mean # of skills mastered	5.2 (53%)	5.3 (56%)	5.3 (55%)
Mean # of skills with gain, not mastered	2.1 (21%)	1.7 (18%)	1.8 (19%)
Mean # skills showing no movement	1.7 (17%)	1.7 (18%)	1.7 (18%)
Mean # of skills showing regress	1.0 (10%)	0.7 (8%)	0.8 (8%)
Mean # of skills attempted	9.9 (100%)	9.4 (100%)	9.6 (100%)

How did students do on the pre- and post-tests?

The second approach to examining student learning outcomes is to examine the increase in the number of items answered correctly between the pretest and the post-test. Because of the highly differentiated nature of School of One, in both instruction and assessment, all students were tested on a different number of skills and on different skills. In School of One, the students were pretested on the skills in their playlist, and students who added additional skills were given a second pretest on the new skills and then a longer post-test to cover the initial skills plus the newly added skills. For consistency, EDC/CCT calculated the percent of items correct from the total number of items on each student's test. School of One used three Acuity items to assess a student on each skill, and the number of skills tested varied from 10 to 19.[4] For example, an assessment of 15 skills would consist of 45 questions total. Using data from the pre- and post-tests, we calculated the percent of items correct for all students.[5]

These data indicate that the pilot students posted an average increase of 28 percent in the number of test items correct (see Table 13). The mean percent of items correct went from 42 percent on the pretest to 70 percent on the post-test.

[4] Data for one student who was only tested on 3 skills was removed from this analysis.
[5] EDC conducted separate analysis only for students who were tested on 14 skills (n=19) and 15 skills (n=18), and the gains varied by less than 2% from the overall data, so data for 75 students is reported here.

Table 13: Percent of items correct on pre- and post-tests (for students tested on 10 or more skills)

	N	Mean	Std. Deviation
Total percent correct on pretest	75	41.6%	14.8
Total percent correct on post -test	75	69.8%	15.5
Increase in percent of items correct	75	28.2%	16.4

The test data from the pilot was also examined by performance level and suggested that students at all performance levels improved their math performance as measured by the Acuity items (see Table 14). Although students at all math achievement levels made substantial gains, the gains were the greatest for Level 2 students, who were classified as below grade-level in math achievement. On average, these students gained 31 points between the pre- and post-tests. Although these students received instruction in fewer skills, they made higher overall gains. The Level 2 students, on average, received instruction in one less skill than their Level 3 and Level 4 peers.

Table 14: Increase in student math performance from pre- to post-test by student achievement level

Achievement level	Increase in percent of items correct	Mean # of skills attempted
Level 1 (N=0)	-	-
Level 2 (N=6)	31.0	8.7
Level 3 (N=46)	28.2	9.6
Level 4 (N=21)	28.9	9.7
Total (N=73)	28.6	9.6

The Experience and Logistics of the Implementation for Students and Teachers

In addition to evaluating whether the School of One approach holds promise for helping students improve in math, the second evaluation task was to examine the feasibility of the model—what are the experiences and logistics of the implementation for students and teachers? Is the model logistically viable?

What are teachers' and students' overall impressions of their experience with School of One?

Results from a survey administered by School of One at the end of the pilot suggest that teachers and support staff enjoyed being part of the School of One program, and all but one agreed that the program had a positive impact on students' math skills. According to one teacher, "It exposed me to a new way of executing instruction. Teaching doesn't always mean standing in front of 30 students with a standard lesson." Another respondent wrote, "[the] individual focus on students really seems to show a significant improvement in mathematical abilities as well as motivation." The majority of respondents also felt that School of One had the potential to transform the way that instruction is individualized in New York City public schools, and that such a program could be particularly helpful for students who struggle in traditional classrooms. One teacher commented, "IEPs could be easily accommodated in this type of setting." Although respondents mentioned the difficulty of adjusting to last-minute scheduling, all but one responded positively when asked if they would participate again in School of One.

Table 15: Responses from the School of One Teacher Survey (n=8)

	Agree	Disagree	Unsure
School of One has the potential to transform the way that instruction is individualized in New York City public schools.	6	1	1
I think School of One has had a significant positive impact on students' math skills.	7	1	-
I feel this program has the potential to be particularly helpful for students who struggle in traditional classrooms.	7	-	1
I would like to participate again as a teacher/intern for School of One.	7	1	-

The School of One team also administered a survey to the students. Overall, students had extremely positive feedback on their experience during the pilot. On the survey, nearly 80 percent reported that they liked going to School of One, and virtually all students appreciated having a schedule that changed every day. According to one student, "One of my favorite things about School of One is that everything is different, unlike regular school, and everyone is doing something different every day." Another student wrote, "I like how School of One teaches only things you don't know." Survey responses also suggest that students enjoyed the schedule delivery, particularly having the schedule in their folders.

Regarding the teaching and learning resources, nearly all students reported that they liked learning math from both their teachers (98.4 percent) and the computer (96.9 percent), and a large majority (87 percent) said they liked asking their friends for help with their

work. One student commented, "My favorite thing about School of One is that we can use laptops to learn math and teachers came around to help you." The students also had favorable views of the online resources, with 73.7 percent saying they liked the educational websites they used in School of One.

Table 16: Responses from the School of One Student Survey

	Disliked	Liked
SO1 core principles		
Going to School of One every day	20.8%	79.2%
Having a schedule that changed every day	3.4%	96.6%
Taking the Playlist Update (the daily assessment)	35.2%	64.8%
Learning source		
Asking friends for help with my work	12.7%	87.3%
Learning math from my teachers	1.6%	98.4%
Using computer to learn math	3.1%	96.9%
Website resources	26.3%	73.7%
Schedule delivery		
Seeing my schedule in my folder	1.6%	98.4%
Seeing my schedule on big board	15.8%	84.2%

Were there traffic problems with so many students and teachers moving between activities?

Logistics and traffic flow (student and teacher movement between assignments) are important features for an approach that envisions students and teachers changing activities and groupings frequently. Over the course of the pilot, the School of One team made constant changes to improve logistic issues and to help student and teachers navigate the dynamic learning process. Aided by the design of the School of One learning space, with open spaces and clear sight lines, the School of One teachers were effective in keeping the focus on learning and the noise-levels down throughout the pilot. The students were informed of the rules for behavior and talking on the first day, and the educators provided constant reminders to students to use their quietest voices. The floor manager played a major role in maintaining order and coordinating student flow between activities. In 30 hours of observations, the researchers never heard the noise level of the 80 students and 10 educators become a distraction.

Television monitors and the floor manager helped students keep track of where they needed to be. Some organizational issues arose regarding the spaces for the virtual instruction and practice, which teachers felt hindered their ability to support students. But the School of One team found solutions to help with these issues. For example, to ease the challenge of proctoring so many students during the virtual instruction activities, the School of One team created signs with the name of each website (i.e. Destination Math) and required students to sit at the table with their assigned website.

Another challenge that emerged was the initial lack of posters or visual aids to help students remember key procedures or strategies. In a traditional classroom, a teacher usually has posters or support material (such as the periodic table, an alphabet chart, or key grammar rules) posted on the walls to help students remember material. Because of the constant movement of students and teachers in School of One, there was concern about how to offer this type of support, as well as how to put student products on the walls. As the pilot progressed, the teachers and School of One team placed common posters and moveable wall materials throughout the library to help fill this perceived need.

How did the School of One approach impact teachers' instructional strategies?

Teachers and residents received professional development and had support from the math specialist and the floor manager. Over the course of the program, EDC was able to identify two types of teaching strategies that may be more common in School of One than in a traditional classroom: proctoring virtual instruction and supporting individual student learning.

One of the benefits of School of One is the opportunity to assign a group of students to do individual online activities to reinforce the specific skills each one needs. During the pilot, researchers were able to observe different teachers' approaches to proctoring this type of class work, where every student is doing something different. Although each teacher adapted differently, supporting so many students simultaneously on such a range of topics was largely a new and challenging role for the teachers. Some teachers reported that proctoring students as they worked on virtual tools was "overwhelming." These teachers reported feeling less comfortable with the idea working with "20 students on 20 different PIs and different programs. I'm never able to focus and find students' misconceptions." They felt it would be hard to keep track of what each child was doing and to uncover students' problems. In the School of One approach, teachers may have to proctor students they have not worked with previously; teachers reported that they would not necessarily know what skill each child was doing or what problems the child might have with that skill. Additionally, the teachers were not familiar with all the virtual resources nor how the resources presented each skill.

However, as the pilot progressed the teacher began to develop strategies to help them work with so many students on such a variety of skills. For example, one teacher said she was able to "monitor kids and see where they needed help. Because I had kids working on the same skill sitting together, I could sit down and do a small-group mini lesson." And teachers did feel that a benefit of the School of One approach was that it helped keep students interested and engaged by eliminating the repetition of material that students had already mastered.

How did teachers handle the daily scheduling produced by the Learning Algorithm?

In the School of One model, scheduling is markedly different than in traditional schooling. At the end of each school day, the Learning Algorithm schedules all students and teachers for the next day. Teachers are freed from the time and effort that, in the traditional model,

goes into scheduling. The teachers in the School of One pilot program reported mixed reactions to the School of One scheduling system: They liked the support in differentiating student work, but were concerned about timing.

The research literature suggests that one of the biggest challenges to differentiated instruction is the amount of time required of teachers to plan and schedule so many different individual education plans.[6] In their interviews, the teachers and residents echoed their colleagues in the belief that School of One "could be beneficial to teachers and students," especially on this issue.

One teacher felt particularly relieved to not have to be responsible for scheduling, explaining that "the algorithm is supposed to give me lessons and I'm supposed to teach the lessons it gives me." He felt this was good for a summer school review program but did not think it would work during the school year. However, other teachers reported that relying on the Learning Algorithm to generate the schedule allowed them to spend more time focusing on teaching. Upon receiving their schedules, teachers reported being able to think about "what are some ways I know how to teach these [skills], and go through the materials" instead of trying to decide which students need which skills. However, they were concerned that the process be improved to deliver schedules in a more timely fashion. In the pilot, schedules were sometimes delivered to teachers late at night, leaving them with "very little time to prepare." As the pilot progressed, teachers reported receiving their schedules earlier on, although this is still an area for improvement.

What was the effect of the School of One approach on making teachers responsible for a subset of PIs?

In the pilot program, the School of One learning progression covered a total of 77 PIs from fifth-, sixth-, and seventh-grade standards. These skills were then divided among the four teachers, each being assigned 18 to 20 skills. The teachers were responsible for overseeing student's progression on those skills, and they would be the teacher for any large- or small-group live instruction on those skills. The teachers had mostly positive reactions about overseeing a subset of skills. This allowed them to focus on developing different strategies to approach a single skill. For example, one teacher liked having the skills broken up "because there are so many different ways you can teach a lesson. If it doesn't work out [one time], I can modify it for next time. It really is a benefit."

School of One staff reported that assigning teachers to specific skills might restrict the flexibility of the Learning Algorithm. Because each teacher is programmed in the Algorithm as only able to teach 19 or 20 of the skills, there is less possible variation when scheduling lesson assignments.

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[6] Stecker, P. M., Fuchs, L. S., & Fuchs, D. (2005). Using curriculum-based measurement to improve student achievement: Review of research. *Psychology in the Schools, 42*(8), 795–819.

What were teachers reactions to the variety of instructional resources being used?

The teachers liked the access to a diversity of resources and the potential for differentiation, but they raised two central concerns. While they recognized that the pilot had to pull together a lot of resources quickly and was not able to fully vet all the materials, they shared concerns regarding the combination of resources. First, teachers were not sure the materials provided enough diversity in the types of learning opportunities for the students. The game, for example, was clearly a different way of learning for the students. But, teachers commented that many of the resources approached math with similar techniques that did not offer students different ways into the material. From their perspective, the websites were mostly variations of "online worksheets," where students answered questions. Although, those could be important reinforcements, teachers felt that students could have benefited from other options—such as visualizations, projects, data analysis activities—that would allow them to apply their math knowledge in different ways. The pilot school in particular does a lot of work with Geometer's Sketchpad®, but none of those activities had been coded and put into the Algorithm.

Teachers also had concerns about shifts in vocabulary between the different resources. There are many ways to talk about math and to annotate math problems, and teachers were concerned that students would be confused by the changing terminology. In the pilot, many students worked on fractions, and the teachers at the school used the phrase "simplify a fraction," but some of the resources used the phrase "reduce a fraction," which teachers felt was leading students to think that the amounts represented were actually smaller.

What did the teachers and math educators think of School of One's approach to math education?

To better understand how math educators felt about the School of One approach to teaching math, EDC/CCT spoke with the math educators who participated in the School of One pilot—four teachers, four teaching residents from NYU's Math for America program, and the school curriculum specialist—as well as the math education specialists from EDC/CCT. From a math education perspective, the educators saw potential in School of One's ability to differentiate and were excited by the pilot experience. But their reflections on the experience pointed to questions regarding the way the approach organizes, orders, and presents math content to students. One of the issues that surfaced concerned the "cohesion in and coherence in the instructional model." A number of the educators explained that, traditionally, math curricula is carefully sequenced because learning math requires procedural and conceptual building blocks to move from one topic to the next. And most curricular resources use spiraling strategies that gradually present content and increased complexity over time, by presenting upcoming concepts in simpler forms that are woven into discussions of earlier topics, in repeat problem sets, and in problem types with increasing complexity, etc. However, the School of One approach is organized around discreet skills, and

the sequence in which an individual student moves from skill to skill varies for each student. Additionally, the instructional resources pull content from different sources, and any coherent thread connecting topic to topic within a curricula may be lost.

Among the educators, concerns arose that the School of One approach to teaching math does not have an explicit method of bridging one skill to another, as well as connecting students back to a larger, more conceptual understanding of mathematical thinking. As one educator observed, the pilot "broke up the skills into these disjointed parts, and if you don't have the connectedness between knowledge, and someone explaining how to use these skills in a larger way…" then students may not understand the conceptual links between skills. The teacher gave an example of "learning to add fractions one day, to divide them another day" both processes use "common denominators" but the algorithms are slightly different. Students may not be taught the underlying reason for the different algorithms and, therefore, not remember them: "each of those algorithms that you learn are related and close to each other, but the confusion that goes on between 'Here's what we're doing today, and tomorrow,' when I say 'common denominator' in different circumstances, they are not getting that." In other words, the processes of adding fractions and dividing fractions are related— they both draw on the concept of how fractions relate to each other. However, if a student memorizes the operations for adding fractions and for dividing fractions, but does not understand the underlying concepts, then that student may end up incorrectly applying that strategy when it comes to dividing fractions.

The EDC/CCT math experts also spoke of the importance of a conceptual understanding as well as procedural (or operational) knowledge, underscoring the importance of conceptual knowledge to support student's retention of the content and foster the ability to apply mathematical knowledge. This may be an area for improvement as the School of One team refines the model.

What were teachers' reactions to the volume of assessment data generated by School of One?

The School of One instructional model, with online daily assessments and daily updates to student progress, produces a wealth of student data that can be made available for teachers. Data reporting for teachers was a feature that the School of One team began to develop half way through the pilot. Teachers reported that having access to this data was helpful. Similar to how the Learning Algorithm takes the weight of scheduling off of teachers, digitally tracking students as they progress through the program removes another administrative task from teachers while still giving them access to important data about their students' learning. As one teacher told researchers, "that's the type of stuff I could never keep track of during the year. I write stuff down like that, but it's not that linear or rational [when I do it]. So the feedback loop was really effective."

While most teachers reported that the data was useful, some expressed a concern that the School of One pilot model, designed to produce a lot of student data, was not designed to allow teachers to make good use of that data. According to one teacher, the wealth of

student data is less valuable due to the differentiated nature of instruction. For example, teachers might be responsible for helping students learn some skills, but they are not teaching them other skills that are connected, or teachers might monitor the progress of a group of students who are being taught skills by a variety of teachers and resources. So, although teachers generally appreciated that the available student data was a "really useful way" to "see feedback," there was a feeling that "because [teachers] do not have a group of students," that data was less helpful.

How did students handle moving between activities?

Students had minimal difficulties changing between activities or navigating their schedules. They moved around the School of One room very well, making use of the on-screen schedules on the televisions located around the room. Researchers observed few instances of students confused about where they were supposed to be. Plus, adults were always in abundance in the School of One room to assist those students who did get confused.
With few exceptions, researchers observed that students were well-behaved throughout the School of One pilot. From the first day of the program, the School of One floor manager stressed to students the importance of speaking at a low volume and being on time for each instructional period. This emphasis was compounded when the floor manager awarded behavior points to the homerooms/teams. Researchers observed students responding positively when those awards were announced, indicating that students, as one student put it, "like that we had to behave."

What did students think about the experience?

Throughout the course of the program, researchers asked students how they liked School of One. Students almost always responded positively, remarking to researchers that they enjoyed School of One because they liked working on computers, and they especially enjoyed "playing games and learning." Further, students told researchers that they liked School of One better than regular school for those same reasons. Researchers also asked students if they were learning at School of One, to which most students responded, "yes," with many adding the similar sentiment that "learning on computers is good because you can go at your own pace."

Towards the end of the program, when researchers asked the students generally reported they had improved on the skills they were attempting to learn. On the final day of the program, researchers observed students as they corrected the pretests that they took at the beginning of the program. One student told researchers he had learned "about the questions I got wrong from School of One," and he was confident that if he "took this test again I would do much better." The student then went on to explain to the researcher how to correctly answer some of the problems he had gotten wrong on the pretest.

What did students think about the Web-based instructional resources they used?

The students' experiences with the educational websites used on the pilot revealed three common threads: (1) the students enjoyed earning points like in a game, (2) they grew bored with the same website; and (3) they were eager to help each other on the websites. *Racking Up Points*: Three of the websites, Math XL, Math Score, and Study Island, used point systems, and students responded well to these systems. Researchers observed that both boys and girls liked earning points, and this often compelled them to do more math problems. The researchers often observed students who had completed their assignments in those programs go back and continue doing problems. When researchers asked why they were going back, some students told researchers that they wanted to practice the skill more, but most students stated that they "just wanna earn points."

Getting bored without variety: The students needed a variety of websites. Students became disengaged and bored working with the same virtual tool over and over again. Though the Learning Algorithm worked to provide students with a schedule consisting of varied learning modalities and different virtual tools, researchers observed some instances of students voicing negative reactions to having to work with the same virtual tool more than once in a day. The School of One team began cycling students through different websites just to give them more variation. Some students also told researchers that the fill-in-the-blank tasks in many of the virtual tools were "boring." For example, the students grew to have an often-voiced dislike to the animated guide from one of the websites.

Working Together: The students easily worked together and helped each other with the technology and websites. Though many students expressed that they liked working on their own with their laptops, researchers observed many instances of students working with virtual tools and helping each other solve problems. Students working together in this way stayed on task, although in most observed instances, the collaboration was rather one-sided: a higher performing student was helping a lower-performing student.

What were students' reactions to using computers?

Overall, researchers observed that students enjoyed working with computers, knowing that teachers were there to support them if they needed help. In general, students expressed a liking for working on their own and felt they were learning. For example, when asked what he liked about School of One, one student told researchers, "I like doing all my work on the laptop, and that sometimes you learn from teachers. I learn best when I am on the laptop, but I need a teacher to help me solve the problems sometimes."

The observation data suggests that, when working on computers so much, students may appear to be focused and learning without problems, but this may be deceiving. Researchers observed that students on the computers were mostly quiet and appeared to be on task. However, when the researchers asked students about what they were doing, it was apparent that students were struggling with the concept and the online resources.

Researchers observed that students had different interactions with the online materials, especially if they did not already have a good grasp of the content. One student described his Web-based activity, as: "it gives you questions you don't know how to answer and you guess," and if you are still having trouble, his advice was "you ask a teacher to help you put in the answer." Another student was initially unfamiliar with the content and struggling to successfully complete the problems, telling a researcher, "I'm not sure how to do this." On his own, he used the website to learn the content. He used a trial-and-error method, putting in an answer, reading the program's explanation of the right answer and trying again until he was able to deduce the underlying pattern. Eventually, after about five tries, the student remarked, "Oh, I get it now," and began to answer the problems correctly.

Another student was also lost while working with algebraic equations on Math XL, but unlike the above example, he was unable to work through the content on his own. When asked what he was supposed to be doing, the student said that he was "not sure" and continued to stare at the screen. The student did not raise his hand to ask for help, nor did a teacher approach the student at any point during the instructional period.
As the teachers themselves commented, it was often difficult to keep track of the students and to intervene when needed. And researchers observed differences in the type of support students received between students willing to ask a teacher for help and students unwilling to do so.

Discussion

School of One is a complex and ambitious undertaking that is innovating on three levels concurrently—assessment, instruction, and scheduling. The long term goal is to reorganize the typical classroom, using technology to support new and different roles for teachers, students, and administrators, and the summer pilot is a first step at generating practical knowledge needed to develop the approach. As a summer program, the School of One pilot may not be completely comparable to a program designed for a regular school year. Nevertheless, the pilot provides valuable insight into the basic nature of the approach and can inform the design of a program that will fit into the regular school-year calendar. The summer program is different from the school year in that most of the content was a review of previously learned material; most students volunteered and were doing well in math; and the pilot was housed in one large space. However, the pilot begins to answer some of the challenging questions generated by an innovation such as this regarding logistics and the learning process. It also identifies pressure points where the model can be improved and enriched.

Logistics

The pilot of the School of One approach set out to test whether it was possible to create a tool and a process such as the Learning Algorithm that could individualize students' instruction *en masse*. The findings from the pilot suggest that the Learning Algorithm—although still in development—easily created individual daily schedules for the students and teachers of School of One.

The data on how the Algorithm distributed resources and instructional modalities suggest that these schedules afforded all students a diversity of instructional modalities and resources, and no group or category of student was concentrated in one type of resource or modality. The Algorithm was able to create a learning environment where every student was engaged with different activities and skills throughout the day, and no two students had the same schedule. Additionally, the Learning Algorithm was sensitive to students' rates of progression and the numbers of students needing different skills and types of instruction.

How did the School of One pilot smooth out traffic flow issues?

In response to logistic concerns and traffic problems, the pilot also appears to have been successful. There were a number of important factors to the successful execution of the pilot. The design of the learning space, the clear rules of behavior, and the television monitors and floor manager helped to create a quiet and orderly environment, where neither students nor teachers were lost, and the noise level was not a distraction. The School of One team played important roles behind the scenes, undertaking part of the planning and preparation work for the teachers. The team was able to prepare and stage the lessons effectively so that the teachers were able to start teaching the assigned lessons each morning without delay or having to arrange materials themselves.

What are the important social aspects underlying the smooth logistics in the School of One model?

Two important factors in making the pilot so logistically smooth were the social dynamics and the focus of the students who participated in School of One. The students were given clear expectations for behavior, and the adults consistently reinforced the same message. Most of the students were from the same middle school in Chinatown, so many of them knew each other and got along well as a group. Most of the students were Level 3 and 4 and generally successful in math. Throughout the program, they were generally focused on their computers or on the task at hand. Even after four hours of math, they were still well-behaved and energetic for the daily assessment at the end of the class.

As School of One rolls out the next version of the program during the school year, the classroom context and the student population will most certainly be different. School of One will need to consider how to translate the factors that contributed to the success of the pilot to other contexts.

Learning Process

The pilot of School of One was also an opportunity to begin understanding how this type of differentiation may affect the learning environment and students' learning outcomes. The pilot experience highlighted a number of dimensions of teaching and learning that changed when students changed teachers, resources, peers, and skills at every lesson. That the pilot students improved on the post-test given on the last day of the program suggests the potential of the model. Nevertheless, there are a number of critical factors that merit further reflection as School of One refines and improves the model.

What are the new pedagogical approaches needed for the School of One model?

The School of One approach creates a demand for teaching strategies and pedagogical approaches to support individual learners that teachers typically would not use in a "whole-class" environment, and with which they may be less familiar. Some teachers found the proctoring strategies and one-on-one approaches initially challenging—it is harder to monitor a number of students working on widely ranging skills and using different materials than when all students are on the same skill and the same set of instructional resources. Plus the types of strategies needed to push students working individually to reflect or deepen their thinking are different than the collaborative and project-based approaches.

How can School of One promote the development of meaningful student-teacher relationships?

The School of One approach represents a change in teacher-student relationships, moving away from one teacher tracking and supporting one student's overall development in math to relationships with multiple teachers for each student, where different teachers may help students with the same skill during different lessons. Especially with struggling students, teachers often leverage their prior knowledge of a students' strengths, weaknesses, or personal understanding of math concepts to introduce new concepts or correct misconceptions. School of One might be able to generate the relevant data for teachers and support their ability to assess a student's understanding or approach.

Can the School of One model provide students with a larger range of social learning experiences?

The pilot of School of One also changed students' social experience of learning so that most of the learning happened in individual contexts. Most of the scheduled activities had students learning on their own, with few project activities, and none that lasted longer than 40 minutes. When teachers had small- or large-group instruction, all activities had to end within the 40-minute lesson period, so few teachers were able to present new material and accomplish group activity. One clear group activity was the video game that the students enjoyed playing.

How does School of One weave a coherent curricular sequence for each student?

The School of One approach represents a change in the relationship between learners and instructional resources. In a traditional math classroom, there is typically a curricular framework that provides a coherent path through the material to support learning, and the coherent path is more than just a sequence of skills. A strong curricular framework has some strengths that math educators value highly, which the pilot teachers attempted to replicate since they found them missing in the pilot experience. A few of the relevant features of a core curricula process are a common vocabulary to enable conversations about math, periodic reviews, and repeated problem sets; it can also gradually expose students to increasing difficulty or complexity within the same skill; and, it can provide a larger conceptual understanding of math. In School of One, each student may use different resources from lesson to lesson that present the material from different perspectives, but the resources may also use different vocabulary or techniques. In the current version, the Learning Algorithm uses a learning progression of discrete skills to create a linear sequence of activities. For example, the Algorithm does not loop students back to skills or schedule refreshers, nor does it purposely schedule students to introductory and then complex levels on a single skill. The School of One development team may want to consider modifying the Learning Algorithm, and the databases that support it, to allow spiraling or increasing complexity or difficulty of the materials.

Learning Outcomes

The pilot experience was a summer program that many students used to revisit content covered during the year, and therefore the students' progression and outcomes will be different than the standard school year when students are working with a larger share of new content. However, the pilot does offer insight into the ways in which the School of One approach might support student learning outcomes.

Overall, the students in the pilot improved their math performance on the post-tests when looked at from two ways. First, students improved (19 percent) or mastered (55 percent) many of the skills they attempted. Second, in terms of the overall post-test score, students increased by 28 percent the items correct on the test. These findings suggest that the School of One approach can increase students' math achievement, and the following sections point to areas where School of One may want to consider refining the model.

Can the School of One model develop mechanisms to ensure slower moving students cover a minimum set of skills each year?

In School of One, students moved through the material at their own pace. Students covered a mean of 9.7 skills, but there was some variation with the Level 2 students who covered one skill less. The pilot was an intensive program of four hours a day, so the variation in pace may change during a standard school year, increasing the distance between students. Since students are held accountable to state and city tests each year, the School of One team may want to revisit how students move through the learning progression. Currently, the Learning Algorithm does not include each student's pace as a variable in scheduling instruction in way that might direct slower moving students to strategies to move them along faster.

How can the School of One model address issues in measuring student knowledge and abilities in ways that can support instructional decision-making?

Although School of One has made great strides in creating an algorithm that makes mass differentiation feasible, the process of benchmarking student knowledge or diagnosing student's instructional needs is a complex task.[7] As the School of One team moves forward, they may want to experiment with other assessments or approaches to identifying students learning needs.

[7] Pellegrino, J., Baxter, G. et al. (1999). Addressing the "two disciplines" problem: Linking theories of cognition and learning with assessment and instructional practice. *Review of Research in Education* 24: 307–353.

Can the School of One model increase students' short-term successes and also support long-term gains in math ability?

Since students progress to a new skill when they pass the daily assessment or reach eight lessons, the difference in the data between the number of skills attempted (9.7) and the number ultimately mastered (5.5) raises a number of questions that should be explored in future implementations. Traditional approaches to learning do not measure or ensure each student has mastered each skill before moving on, so without a valid comparison group and appropriate measures, it is impossible to substantiate whether the rate of retention is different than retention in traditional classrooms.

How can the School of One model ensure that students have opportunities to build conceptual and critical understanding of content?

As a summer program, the pilot focused primarily on developing students' operational knowledge of math. Developing students' broader conceptual mathematical understanding was a concern for the teachers and educators in the program. The School of One team may want to explore whether the current learning progression does or does not address the broader conceptual context of math and consider how to address this concern.

Conclusion

Described by its designers as a first-of-its-kind initiative, the School of One pilot was an initial step in a significant effort at innovation. The School of One approach is intended to transform three traditional processes concurrently—assessment, instruction, and scheduling—and thus represents a new model for how schools can function. The long-term validation of the model will require a focus on student learning outcomes, but, at this early stage, when many components of the process are tentative and open to revision (i.e., altering instructional resources, diagnostic techniques, and other aspects of the model), the evaluation focus was on the feasibility of the model, and whether it offers the potential for impact on student learning that warrants continued effort.

In response to both of those concerns, the pilot evaluation findings suggest that the core of School of One holds potential. Although there are a number of ways the approach can be refined and improved, the Learning Algorithm was able to produce daily schedules for teachers and students that kept students moving forward on their playlists. The learning environment created for the pilot also functioned smoothly, with minimal confusion among the students and teachers. The findings also suggest that the constant variation that students

experienced did not keep them from mastering the targeted content, and the School of One program did help students improve their math performance.

The tremendous flexibility of the School of One approach suggests many paths for further development of this model. As the School of One team moves from a summer program to a typical school setting, they will need to capitalize on that flexibility to meet the challenging requirements and constraints of that context. The Learning Algorithm can work with many types of assessment data, instructional resources, and modalities. The School of One team should take advantage of this strength to explore ways to incorporate an even greater range of contents, assessments, and instructional models.

Appendix A

NYS Number	New York State Performance Indicators
5.N.2	Compare and order numbers through the millions
5.N.3	Understand the place value structure of the base ten system
5.N.5	Compare and order fractions including unlike denominators (with and without the use of number line)
5.N.7	Express ratios in different forms
5.N.9	Compare fractions using <,>, or =
5.N.10	Compare decimals using <,>, or =
5.N.12	Recognize that some numbers are only divisible by one and themselves (prime) and others have multiple divisors (composite)
5.N.13	Calculate multiples of a whole number and the least common multiple of two numbers
5.N.14	Identify the factors of a given number
5.N.15	Find the common factors and the greatest common factor of two numbers
5.N.17	Use a variety of strategies to divide three digit numbers by one and two digit numbers
5.N.20	Convert improper fractions to mixed numbers and mixed numbers to improper fractions
5.N.21	Use a variety of strategies to add and subtract fractions with like denominators
5.N.22	Add and subtract mixed numbers with like denominators
5.A.2	Translate simple verbal expressions into algebraic expressions
5.A.3	Substitute assigned values into variable expressions and evaluate using order of operations
5.A.6	Evaluate the perimeter formula for given input values
5.A.7	Create and explain patterns and algebraic relationships
5.G.4	Classify quadrilaterals by properties of their angles and sides
5.G.6	Classify triangles by properties of their angles and sides
5.G.11	Identify and draw lines of symmetry of basic geometric shapes
5.S.4	Formulate conclusions and make predictions from graphs
6.N.2	Define and identify the commutative and associative properties of addition and multiplication
6.N.3	Define and identify the distributive property of multiplication over addition
6.N.4	Define and identify the identity and inverse properties of addition and multiplication
6.N.7	Express equivalent ratios as proportions
6.N.11	Read, write and identify percents of a whole
6.N.12	Solve percent problems involving percent, rate, and base
6.N.15	Order rational numbers (including positive and negative)
6.N.16	Add and subtract fractions with unlike denominators
6.N.17.1	Multiply fractions with unlike denominators
6.N.19	Identify reciprocals of given fractions

6.N.17.2	Divide fractions with unlike denominators
6.N.18.1	Add and subtract mixed numbers with unlike denominators
6.N.18.2	Multiply and divide mixed numbers with unlike denominators
6.N.18.3	Add and subtract fractions and mixed numbers in problem solving situations
6.N.21	Find multiple representations of rational numbers (fractions, decimals, and percents from 0-100)
6.N.22	Evaluate numerical expressions using order of operations (may include exponents of two and three)
6.N.23	Represent repeated multiplication in exponential form
6.N.26	Estimate a percent of quantity (0-100%)
6.N.27	Justify the reasonableness of answers using estimation (including rounding)
6.S.7.1	Read and interpret graphs: compare graphic data
6.S.7.2	Read and interpret graphs: Understand construction of convincing arguments from data
6.A.1	Translate two step verbal expressions into algebraic expressions
6.G.2.1	Determine the area of triangles and quadrilaterals and develop formulas: Areas of rectangles and squares using grids
6.G.3	Use a variety of strategies to find the area of regular and irregular polygons
6.G.4	Determine volume of rectangular prisms by counting cubes and developing formula
6.G.5	Identify radius, diameter, chords, and central angles of a circle
6.G.6	Understand the relationship between the diameter and radius of a circle
6.G.7	Determine the area and circumference of a circle using the appropriate formula
6.M.7	Estimate volume, area, and circumference
7.S.2	Display data in a circle graph
7.S.3	Convert raw data into double bar graphs and double line graphs
7.S.5	Select the appropriate measure of central tendency (Mean, Median, Mode)
7.S.6.1	Read and interpret data represented graphically: Histograms
7.S.6.2	Read and interpret data represented graphically: Circle graphs
7.S.7	Identify and explain misleading statistics and graphs
6.S.10	Determine the probability of dependent events
7.S.8	Interpret data to provide the basis for predictions and to establish experimental probabilities
7.S.9	Determine the validity of sampling methods to predict outcomes
7.S.10	Predict the outcome of an experiment
7.N.1	Distinguish between the various subsets of real numbers
7.N.3	Place rational numbers on a number line
7.N.4	Develop the laws of exponents for multiplication and division
7.N.5	Write numbers in scientific notation
7.N.8	Find the common factors and the greatest common factor of two or more numbers
7.N.9	Determine multiples and least common multiples of two or more numbers
7.N.13	Add and subtract two integers (with and without the use of a number line)

7.N.12	Add, subtract, multiply, and divide integers (word problems)
7.N.15	Recognize and state the value of the square root of a perfect integer (up to 225)
7.N.18	Identify the two consecutive whole numbers between which the square root of a non-perfect square whole number less than 225 lies (with and without the use of a number line)
7.A.5	Solve one step inequalities (positive coefficients only)
7.G.10	Graph the solution set of an inequality (positive coefficients only) on a number line
7.A.6	Evaluate formulas for given input values: rate
7.G.3	Identify the two-dimensional shape that makes up the faces and bases of three dimensional shapes (prisms, cylinders, cones, and pyramids)
7.G.4	Determine the surface area of prisms: cubes and rectangular solids
7.G.7	Find the missing angle in a quadrilateral

Appendix B

School of One Pilot: Student Outcomes on Fifth-Grade Performance Indicators						
Skill	**Number of Students Diagnosed with Skill**	**Number of Students**	**Mean Exposures**	**Mean Pretest**	**Mean Post-Test**	**Mean Gains**
5.A.02	21	11	4.55	0.45	1.00	0.57
5.A.03	39	31	5.58	0.22	0.71	0.48
5.A.06	22	16	6.13	0.02	0.92	0.90
5.A.07	44	41	8.00	0.23	0.50	0.28
5.G.04	10	5	7.60	0.60	0.80	0.20
5.G.06	17	8	3.63	0.58	1.00	0.42
5.N.02	5	2	5.00	0.00	0.67	0.67
5.N.03	16	1	2.00	0.33	1.00	0.67
5.N.05	8	5	8.80	0.33	0.58	0.33
5.N.07	31	19	7.58	0.19	0.65	0.48
5.N.09	10	4	7.00	0.00	0.75	0.75
5.N.10	13	5	4.00	0.08	0.87	0.80
5.N.12	24	17	4.47	0.18	0.58	0.38
5.N.13	7	6	5.00	0.33	0.78	0.50
5.N.14	28	6	5.00	0.47	0.60	0.20
5.N.15	11	7	4.29	0.48	0.80	0.27
5.N.17	37	30	7.40	0.23	0.72	0.49
5.N.20	10	7	5.29	0.38	0.47	0.07
5.N.22	11	2	4.00	0.00	0.67	0.67
5.S.04	2	1	4.00	0.67	1.00	0.33

School of One Pilot: Student Outcomes on Sixth-Grade Performance Indicators						
Skill	**Number of Students Diagnosed with Skill**	**Number of Students Attempting Skill**	**Mean Exposures**	**Mean**	**Mean Post-Test**	**Mean Gains**
6.A.01	61	18	4.17	0.51	0.52	0.04
6.G.02.1	43	6	3.67	0.44	0.44	0.00
6.G.04	21	8	3.38	0.33	0.67	0.38
6.G.05	23	4	3.25	0.50	1.00	0.50
6.G.06	9	1	7.00	0.00	0.67	0.67
6.G.07	55	25	4.36	0.41	0.80	0.44
6.M.07	18	4	4.75	0.33	0.75	0.42
6.N.02	66	42	4.38	0.18	0.85	0.68
6.N.03	69	60	5.85	0.10	0.58	0.49
6.N.04	62	51	4.16	0.11	0.88	0.78
6.N.07	42	35	4.57	0.25	0.76	0.51
6.N.11	34	18	5.11	0.35	0.53	0.22
6.N.12	46	14	4.71	0.36	0.85	0.58
6.N.15	51	35	4.37	0.33	0.56	0.26
6.N.16	18	9	4.56	0.11	0.83	0.75
6.N.17.1	13	7	4.00	0.10	0.95	0.86
6.N.17.2	47	21	3.29	0.12	0.82	0.70
6.N.18.1	17	5	4.00	0.07	0.67	0.60
6.N.18.2	45	19	4.21	0.40	0.70	0.37
6.N.18.3	33	7	2.29	0.52	0.94	0.39
6.N.19	30	8	3.75	0.04	0.83	0.79
6.N.21	20	5	5.60	0.40	0.93	0.53
6.N.22	24	6	3.67	0.44	0.78	0.33
6.N.23	4	2	2.00	0.00	1.00	1.00
6.N.26	45	27	3.70	0.33	0.73	0.39
6.N.27	15	2	2.00	0.67	0.83	0.17
6.S.07.1	11	3	4.33	0.33	1.00	0.67
6.S.07.2	34	13	7.00	0.47	0.74	0.31
6.S.10	48	26	5.81	0.23	0.76	0.56

School of One Pilot: Student Outcomes on Seventh-Grade Performance Indicators						
Skill	**Number of Students Diagnosed with Skill**	**Number of Students Attempting Skill**	**Mean Exposures**	**Mean Pretest**	**Mean Post-Test**	**Mean Gains**
7.A.05	28	8	3.50	0.48	0.28	-0.17
7.A.06	11	1	2.00	0.67	1.00	0.33
7.G.04	22	4	3.00	0.11	1.00	0.92
7.G.10	17	4	2.50	0.00	0.67	0.67
7.N.01	40	20	4.10	0.27	0.69	0.43
7.N.03	9	1	8.00	0.67	1.00	0.33
7.N.04	32	17	4.88	0.24	0.62	0.38
7.N.05	30	11	2.55	0.14	0.67	0.62
7.N.08	6	1	2.00	--	1.00	--
7.N.09	17	1	2.00	0.67	1.00	0.33
7.N.12	13	2	2.00	0.67	0.67	0.33
7.N.13	27	5	2.40	0.44	0.92	0.58
7.N.15	19	1	2.00	0.67	1.00	0.33
7.N.18	12	1	2.00	0.67	1.00	0.33
7.S.02	27	9	3.44	0.54	0.89	0.41
7.S.03	18	5	2.00	0.42	0.83	0.42
7.S.05	37	15	5.07	0.33	0.44	0.16
7.S.06.1	11	1	2.00	0.67	--	--
7.S.06.2	33	9	5.22	0.30	0.78	0.48
7.S.07	27	7	3.43	0.39	0.67	0.33
7.S.08	19	6	4.67	0.53	0.89	0.44
7.S.09	15	6	3.00	0.56	1.00	0.44
7.S.10	20	12	3.33	0.57	0.97	0.61
Total	1860	852	4.86	0.27	0.73	0.47

Appendix C

School of One Pilot: Distribution of Instructional Modality by Performance Indicators

Skill	Teacher-led instruction	Teacher-led practice	In-school tutoring	Individual practice	Virtual instruction	Virtual practice	Virtual tutoring	Video games
5.A.02	14%	0%	3%	9%	29%	29%	16%	0%
5.A.03	33%	0%	7%	0%	18%	42%	0%	0%
5.A.06	13%	4%	2%	10%	23%	36%	12%	0%
5.A.07	47%	0%	3%	17%	0%	22%	9%	2%
5.G.04	0%	0%	0%	35%	13%	43%	10%	0%
5.G.06	0%	0%	0%	10%	28%	33%	15%	13%
5.N.02	14%	14%	5%	14%	14%	36%	5%	0%
5.N.03	0%	0%	0%	0%	88%	6%	6%	0%
5.N.05	14%	6%	7%	30%	19%	11%	13%	0%
5.N.07	30%	0%	4%	11%	15%	36%	5%	0%
5.N.09	13%	0%	28%	44%	0%	0%	16%	0%
5.N.10	13%	0%	0%	8%	38%	25%	4%	13%
5.N.12	20%	0%	2%	18%	28%	16%	7%	9%
5.N.13	0%	0%	7%	10%	33%	37%	13%	0%
5.N.14	2%	0%	13%	11%	20%	41%	13%	0%
5.N.15	0%	0%	5%	8%	34%	29%	24%	0%
5.N.17	22%	11%	4%	7%	11%	35%	8%	3%
5.N.20	0%	0%	14%	16%	27%	19%	24%	0%
5.N.22	0%	0%	0%	13%	50%	19%	19%	0%
5.S.04	0%	0%	0%	25%	25%	25%	25%	0%
6.A.01	10%	11%	4%	17%	31%	12%	7%	10%
6.G.02.1	0%	0%	0%	9%	32%	36%	23%	0%
6.G.04	7%	0%	7%	22%	26%	11%	26%	0%
6.G.05	0%	0%	0%	31%	23%	15%	31%	0%
6.G.06	0%	0%	38%	13%	25%	13%	13%	0%
6.G.07	17%	14%	0%	15%	25%	23%	6%	0%
6.M.07	0%	0%	9%	9%	17%	44%	22%	0%
6.N.02	33%	17%	1%	8%	16%	11%	4%	10%
6.N.03	41%	13%	1%	10%	13%	17%	5%	0%
6.N.04	30%	30%	3%	18%	0%	0%	15%	5%
6.N.07	22%	6%	1%	11%	25%	28%	5%	2%
6.N.11	16%	9%	3%	13%	26%	28%	6%	0%
6.N.12	25%	23%	0%	7%	17%	22%	3%	3%

(continued)

School of One Pilot: Distribution of Instructional Modality by Performance Indicators (continued)

Skill	Teacher-led instruction	Teacher-led practice	In-school tutoring	Individual practice	Virtual instruction	Virtual practice	Virtual tutoring	Video games
6.N.15	20%	26%	1%	12%	24%	13%	4%	0%
6.N.16	20%	10%	5%	12%	42%	5%	7%	0%
6.N.17.1	0%	0%	3%	23%	40%	23%	10%	0%
6.N.17.2	4%	0%	4%	15%	26%	33%	17%	0%
6.N.18.1	0%	0%	0%	0%	32%	46%	23%	0%
6.N.18.2	23%	6%	1%	2%	29%	35%	4%	0%
6.N.18.3	19%	0%	0%	0%	50%	13%	19%	0%
6.N.19	14%	0%	3%	20%	26%	17%	20%	0%
6.N.21	0%	0%	21%	28%	17%	17%	17%	0%
6.N.22	15%	0%	0%	23%	23%	23%	15%	0%
6.N.23	0%	0%	0%	0%	0%	50%	50%	0%
6.N.26	5%	9%	6%	26%	21%	11%	14%	9%
6.N.27	0%	0%	17%	17%	0%	33%	33%	0%
6.S.07.1	0%	0%	15%	0%	39%	31%	15%	0%
6.S.07.2	10%	7%	9%	8%	21%	37%	8%	0%
6.S.10	33%	0%	6%	8%	17%	20%	6%	11%
7.A.05	0%	0%	0%	35%	29%	21%	15%	0%
7.A.06	0%	0%	0%	0%	50%	0%	50%	0%
7.G.04	0%	0%	0%	8%	17%	33%	42%	0%
7.G.10	0%	0%	0%	15%	0%	54%	31%	0%
7.N.01	29%	14%	2%	13%	15%	20%	8%	0%
7.N.03	0%	0%	42%	17%	17%	8%	17%	0%
7.N.04	24%	9%	1%	19%	15%	31%	1%	0%
7.N.05	10%	0%	0%	23%	26%	19%	23%	0%
7.N.08	0%	0%	0%	50%	0%	0%	50%	0%
7.N.09	0%	0%	0%	14%	0%	71%	14%	0%
7.N.12	0%	0%	0%	0%	29%	57%	14%	0%
7.N.13	0%	0%	0%	0%	50%	20%	15%	15%
7.N.15	0%	0%	0%	43%	43%	14%	0%	0%
7.N.18	0%	0%	0%	0%	38%	50%	13%	0%
7.S.02	0%	0%	6%	24%	33%	21%	15%	0%
7.S.03	0%	0%	0%	8%	58%	8%	25%	0%
7.S.05	4%	4%	5%	22%	28%	22%	15%	0%
7.S.06.1	0%	0%	0%	0%	29%	57%	14%	0%
7.S.06.2	6%	0%	8%	8%	34%	32%	13%	0%
7.S.07	0%	0%	0%	8%	42%	31%	19%	0%
7.S.08	9%	0%	9%	18%	21%	15%	27%	0%
7.S.09	0%	0%	6%	17%	28%	22%	28%	0%
7.S.10	19%	7%	2%	9%	22%	24%	17%	0%
Total	21%	7%	4%	13%	19%	23%	10%	2%