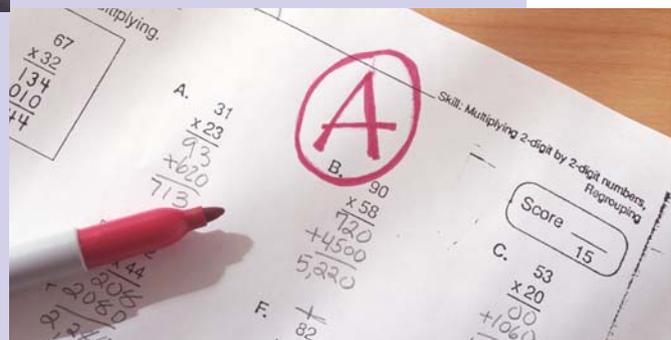


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Using Accelerated Math™ to Enhance Instruction in a Mandated Summer School Program



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Using Accelerated Math™ to Enhance Instruction in a Mandated Summer School Program

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Executive Summary ---

It is common practice for school systems to mandate remedial summer school for students who fail state tests. Often the math instruction in these mandated programs is a repeat of experiences students have already had using instructional methodologies that failed in the past. The purpose of this study was to examine the extent to which Accelerated Math™, a curriculum-based monitoring system or learning information system, would enhance math outcomes for students, specifically students whose previous achievements were among the lowest in an urban school district. We conducted the study in as naturalistic (non-contrived) a setting as possible: a mandated six-week summer session in an upper-Midwest inner city public school system. Students who had not passed a state math test necessary to graduate from high school, or who performed below the 40th percentile on a district-administered, nationally-normed test, were required to attend the summer instructional programs.

Accelerated Math uses technology that monitors practice of foundational skills while providing immediate feedback on performance to both the student and the teacher, ensuring that each student works at his or her own pace with a continuous supply of new and relevant problems and assignments. Accelerated Math also handles all scoring and record-keeping tasks, minimizing teacher paperwork and time. Despite the short duration of the summer session, six weeks of half-day instruction (approximately total 24 hours of instruction), as well as difficult learning conditions, students made exceptional growth in math as measured by re-administering a district test and STAR Math™ (a companion program to Accelerated Math).

Student rate of progress outside of actual intervention (i.e., prior to and following the use of Accelerated Math programming) paled in comparison to the accelerated growth demonstrated during this summer session programming. Student growth on the Northwest Achievement Levels Test (NALT)—a district administered measure—for the nine months prior to implementation of Accelerated Math was 2.68 Normal Curve Equivalents (NCE). Student performance nine months following

the use of Accelerated Math was 1.7 NCEs (during this time, students received no further Accelerated Math interventions). However, during the six-week implementation of Accelerated Math, student rate of growth in mathematics increased an average of 5.51 NCEs on the NALT, and 2.6 NCEs on STAR Math. When analyzing data on matched pairs (students for whom test scores exist at both points in time) the NALT gains were an impressive 5.75 NCE units immediately following intervention compared to 3.2 NCEs for the entire nine month instructional period preceding the intervention.

If students maintained a consistent percentile rank on either measure from pre- to post-testing, their NCE growth would be zero. In effect, students would be considered to be gaining new skills, but not at an accelerated rate so as to increase their overall standing in comparison to same-age or same-grade peers. Thus, an NCE gain above zero is seen as acceleration in the rate of student progress. Use of both an A-B-A evaluation design and a pre-post design demonstrated the effectiveness of Accelerated Math in accelerating student rate of progress. Overall, students gained more during the short summer school program using a learning information system than they did in the nine-month pre- or post-summer academic year. A learning information system such as Accelerated Math is a powerful intervention for improving the mathematics performance and skills of low achieving students in urban school districts.

Overview

Today, there is no shortage of media coverage on academic achievement in our nation's schools. Through front-page headlines, TV news reports, and magazine cover stories, we know much about students' progress in reading and math. We learn that scores on math tests are increasing, and the improvements are noteworthy. For example, compared to 1990 assessments, students' scores on the 1996 National Assessment of Educational Progress (NAEP) mathematics assessments improved in all grades tested (grades 4, 8, and 12). The percent of fourth-grade students at or above the basic level for their grade improved from 50% in 1990 to 64% in 1996. For eighth grade, the percent increased from 52% at or above grade level in 1990 to 62% in 1996, and twelfth-graders improved from 58% to 69% at grade level.

Despite this progress, U.S. eighth-graders score below the 41-nation international average in math. Obviously, there is room for improvement. In 1998, the U.S. Department of Education (1998a) reported that eighth-graders in 20 countries outperformed U.S. eighth-graders on the Third International Math and Science Study, whereas U.S. eighth-graders scored higher than their peers in seven countries. The pattern of low achievement in mathematics for significant numbers of students who attend schools in large urban districts is well documented. Moreover, the relatively poor performance of these students on state and district tests is documented in state and local reports (Ysseldyke, Thurlow, Langenfeld, Nelson, Teelucksingh & Seyfarth, 1998). In Minnesota, for example, more than half of grade 8 students from Minneapolis and St. Paul do not pass the Minnesota Basic Standards Test (1996-99). This is a contrast to the rest of the state where nearly 70% of eighth-graders passed the math portion of the Minnesota Basic Standards Test (MBST) in 1999.

The basic standards in Minnesota represent the basic skills that all students should have in a literate society. They are the "safety net" portion of Minnesota's graduation standards. Students must pass tests in reading, mathematics, and writing to show they meet the basic standards in order

to be eligible to graduate from a public high school. The MBSTs are not graduation-level tests. Rather, they represent the minimum level of math, reading, and written composition recommended for survival in adult life. The reading and mathematics tests are first given in the eighth grade, and the written composition test is given in the tenth grade. Students scoring below the state required passing level (currently 75% correct) must retake the test each year until they achieve a passing score.

The specifications for the mathematics test were shaped with the help of Minnesota mathematics teachers throughout the state. The test covers (1) eight different areas of math content, material that students are introduced to before the sixth grade; (2) problems in the context of real-world applications; and (3) problems involving numbers, shapes, and symbols commonly used in adult life.

Most of the students who perform poorly or who fail state tests are students who perform below grade level on standardized tests or fall below 50% when compared to national norms.

What Do School Personnel Do in Response to Failure?

In general, the answer to the above question is “a lot.” At the national level, low performance of students relative to those in other nations has led to calls for massive school reform. A council of U.S. governors specified eight national education goals, and there are repeated calls (e.g., Ysseldyke, Thurlow & Linn, 1999) for standards and accountability for all students. State departments of education have been extensively engaged in writing or re-writing their standards. Professional associations like the National Council of Teachers of Mathematics have issued math standards and recommendations for teaching math (NCTM, 1989). There is extensive talk about “ratcheting up” standards. School districts are examining and changing their curricula, and personnel in some schools are implementing interventions to enhance results of instruction. Sometimes the interventions are programmatic (e.g., putting

early compensatory education experiences into place, or extending the school day), and sometimes they are curricular (e.g., changing to a new curriculum, or implementing computer-assisted instruction). In addition, school personnel are given training in effective instruction (e.g., training all teachers in programs like Strategies and Tactics for Effective Instruction [Algozzine, Ysseldyke, & Elliott, 1997; Elliott, Algozzine, & Ysseldyke, 1998]). Still others are given training in instructional management systems (sometimes called learning information systems; e.g., curriculum-based instruction or Accelerated Math™).

More recently, extended school year or summer school programming has become one of the preferred tactics in the battle to improve test scores. Local school boards and administrators increasingly are mandating summer school attendance for students who perform poorly on or do not pass state or district tests. For example, the Minneapolis and St. Paul public schools required summer school in 1998 for all eighth-graders who failed the state tests. It is expected that 12,500 students in St. Paul and 15,000 students in Minneapolis will be enrolled in remedial programs during the summer of 1999.

We decided to target one summer session lasting six weeks to implement an intensive intervention, with a learning information system that monitors student performance and provides teachers with information that is necessary to appropriately place students in the curriculum (i.e., match current skill level to curricula objectives). Our goals were to: (1) examine the extent to which such a system would enhance math outcomes for students, (2) focus our efforts on students whose previous achievements were among the lowest in an urban school district, and (3) conduct the study in as naturalistic (non-contrived) a setting as possible. We recruited two middle school sites from the Minneapolis public schools.

Method

Accelerated Math, a learning information system (LIS), was implemented in a mandatory summer session program in the Minneapolis Public Schools. District and state tests were used in addition to STAR Math™, a computer-adaptive math test, to evaluate gains in student performance.

Learning Information System

Accelerated Math (developed by Advantage Learning Systems, Inc., 1998) is a task-level learning information system that helps teachers ensure student achievement in all math objectives. Accelerated Math encourages and monitors practice of foundational skills while providing immediate feedback on performance to both the student and the teacher. The program uses Objective Tracker™ technology and a powerful Algorithm Problem Generator™ to ensure that each student works at his or her own pace with a continuous supply of new and relevant problems and assignments. Accelerated Math handles all scoring and record-keeping chores, minimizing teacher paperwork and time.

Minneapolis Summer Session Programming

Summer session in Minneapolis has a simple, clear purpose: to ensure that Minneapolis students graduate. The district organizes and plans the Summer Session around four goals: (1) Increase enrollment of students who have not passed the MBST; (2) collaborate with the community-religious, governmental, and community-based organizations to enrich the Summer Session programs; (3) improve assessment of Summer Session students; and (4) investigate enrichment opportunities for students who do not qualify for Summer Session.

Two schools were chosen as settings for the summer school study, and school personnel bid on participation in the project. The summer program

ran for a six-week period beginning June 15 and ending July 24. Summer programming was held four days per week for each of the six weeks, and each school day was four-to-five hours long. Only reading and math were taught, and each class was scheduled for about 90 minutes. Thus, maximum time available for teaching math was 2,160 minutes. Yet, almost two weeks of instruction was dedicated to summer registration and enrollment, pre- and post-testing on STAR Math and district assessments. Occasional events such as viewing a televised soccer match (one day), and a party day during the last day of school, also intruded upon academic instruction. Thus, time allocated to math instruction was about 1,440 minutes (or about 24 hours). Furthermore, attendance was sporadic; though the summer school program was mandated, several students did not want to be there. During the summer session, teachers continued to use Every Day Math as the primary curriculum. In addition, teachers were asked to organize instruction to meet the eight instructional areas addressed on the Minnesota Basic Skills test: whole numbers and fractions, ratios and percents, number sense, estimation, measurement, tables and graphs, chance data, and shapes and space.

Teacher Training

Once settings were selected, teacher training was conducted for two days. Teachers were trained in the use of Accelerated Math as a learning information system. Training was supplied by an official trainer provided by the publisher. In spite of the bidding process and buy-in, some teachers did not show up for the training, and some attended only one of the two days. Only three of the pilot teachers were present for both days. Of those present, most left the training frequently for a variety of professional and personal matters.

Intervention Implementation

Five classrooms were involved in this summer school intervention. Table 1 lists the classrooms, grade levels, and enrollment.

Table 1. Teachers, Schools, and Enrollment

Teacher	Grades Taught	School Setting	Enrollment
1	6, 7	Site 1	20
2	7, 8	Site 2	22
3	8	Site 2	31
4	6, 7, 8	Site 2	29
5	7, 8	Site 2	37

Students enrolled at Site 1, a Spanish immersion school, included 37% LEP students, 16% receiving special education services, and 58% female. Overall, attendance was variable and ranged between 20 and 25 students. Classroom aides and volunteers assisted students who were stronger English speakers, and the classroom teacher, who was bilingual, assisted with translating word problems for students with more limited English proficiency. Instruction was delivered one-to-one and in small groups, and students progressed as they mastered objectives. Adult assistants monitored the computer and helped students scan worksheets and complete tests. Students were not allowed to use the computer without adult assistance.

At Site 2, four teachers used Accelerated Math with students in sixth through eighth grades. Three of those teachers used the program with their morning and afternoon math classes. The fourth teacher taught ESL students and used Accelerated Math in the afternoon with the same group of students. Of the students participating, 39% were LEP students, 16% received special education services, and 48% were female. Attendance varied widely-ranging from 10 to 20 students per class and decreased toward the end of the summer. Implementation of Accelerated Math also varied by classroom and changed as the summer progressed. Two teachers were actively involved in teaching and providing feedback to their students. The other two teachers primarily functioned as classroom and computer monitors, and students used the computer and worksheets independently, essentially functioning without teacher

instruction. Teachers also faced balancing Accelerated Math objectives and the objectives set by the school's math curriculum coordinator. Often students had not mastered an Accelerated Math objective, but their teacher felt compelled to move on to the next objective in the school curriculum.

Classroom Conditions and Circumstances

Classroom conditions were very difficult. The summer program was held in buildings without air-conditioning, and temperatures exceeded 90 degrees on most days. Teachers were recruited to teach summer school, and district teacher selection was not based on skill or experience in teaching reading and math. Several of the teachers were vocational educators or taught science, history, or social studies during the regular school year. We made no effort to modify these difficult conditions as we were interested in how our intervention would work under naturally occurring circumstances.

Measures of Student Performance and Progress

District Testing

Every student in grades 2 through 7 was tested in spring 1997, spring 1998, and spring 1999 on the math portion of the Northwest Achievement Levels Test (NALT) (Northwest Evaluation Association). Eighth-grade students are required to take the Minnesota Basic Standards Test (MBST), and each eighth-grade student took the MBST in February preceding the 1998 summer school program. Students who either failed the MBST or who scored below the 40th percentile on the district's spring 1998 administration of the NALT were mandated to attend summer school for instruction in reading and math. Tests were administered across time as depicted in Table 2.

Table 2. Dates When Tests were Administered

Test	2/97	4/97	2/98	4/98	6/98	7/98	2/99	4/99
Minnesota Basic Standards Test	X		X			X	X	
Northwest Achievement Levels Test		X		X				X
STAR Math					X	X		

STAR Math Testing

Students were also evaluated using the STAR Math exam (Advantage Learning Systems [ALS], 1997, 1998), a computer-adaptive test of math skills. STAR Math is designed for use with grades 3 to 12 and measures skills in numeric concepts, computation, and math application. The test takes approximately 15 minutes and requires students to respond to 24 questions.

Pre-testing at one middle school (Site 1) was conducted during the first week of summer school and post-testing occurred during the last week of summer school. Pre-testing at the other school (Site 2) was conducted from June 15 through July 1, and post-testing was conducted from July 16 through July 20. Students were tested in computer labs under the supervision of their teacher or lab assistants. Results are reported as the change from pre- to post-testing as measured by Normal Curve Equivalents (NCEs). The STAR Math test is used for two purposes. First it is used to place each student at the appropriate level in the curriculum; second, as a post-test to determine student growth. The adaptive branching technology used with this system continuously adjusts each test to the abilities of each individual. Students who answer correctly are presented a more difficult item, while those who answer incorrectly are given an easier item. In this way the test narrows in on the instructional level of the student. The test provided grade equivalents, percentile ranks, and NCEs.

Results

Both qualitative and quantitative data were collected. Qualitative data included information on library placement, median number of objectives mastered by classroom, an approximation of student time on task (calculated by estimating that individual students spend about 30 minutes per objective mastered in Accelerated Math), and number of objectives mastered by the top two students in each class. There was considerable variability across classrooms for the numbers of objectives mastered by individual students during the 16 days of instruction. The highest number of objectives mastered by a student was 103 (see Table 3).

Table 3. Qualitative Data

Teacher	No. of Students	Library Placement	Median Objectives Mastered	Estimated Average Time on Task	Top Two Students' Objectives Mastered
1	20	Third	33	62 min/day	72 and 59
2	22	Third	18	34 min/day	87 and 75
4 (1)	15	Third	18	34 min/day	58 and 51
4 (2)	16	Third	21	40 min/day	95 and 72
5 (1)	18	Third	24	45 min/day	41 and 36
5 (2)	11	Third	31	58 min/day	103 and 77
6 (1)	18	Fourth	45	84 min/day	71 and 64
6 (2)	19	Fourth	26	49 min/day	88 and 74

Test Performance

In the nine-month period preceding implementation of the Accelerated Math summer session intervention, students gained an average of 2.68 NCEs on the Minneapolis district portion of the NALT. Immediately following the Summer Session intervention, students posted an average gain of 5.51 NCE units on the district NALT, nearly twice the amount of growth demonstrated during the previous nine months. In the nine

months following Accelerated Math participation, students gained only 1.7 NCE on the NALT (during that time, they received no Accelerated Math interventions) (see Figure 1). When analyzing data on 33 students for whom test scores existed at two points in time, the NALT gains were an impressive 5.75 NCE units immediately following intervention compared to 3.2 NCEs for the entire nine month instructional period preceding the intervention. Furthermore, students gained 2.64 NCEs on STAR Math. If students maintained a consistent percentile rank on either measure from pre- to post-testing, their NCE growth would be zero. In effect, students would be considered to be gaining new skills, but not at an accelerated rate so as to increase their overall standing in comparison to same-age or same-grade peers. Thus, an NCE gain above zero is seen as acceleration in the rate of student progress. Overall, gains were demonstrated on both the NALT and STAR administered tests, corroborating the powerful effect of the intervention on student performance.

Performance on the MBST is scored by calculating the percent of items passed on the test. The Minnesota Department of Children, Families and Learning requires a student to pass 75% of the items to be eligible to graduate from high school. Therefore, a third measure of change in performance as a function of the summer school intervention is change

Figure 1. Mean Math NCE Gains

April '97	April '98	June '98	July '98	April '99
Prior to Accelerated Math Intervention		Accelerated Math	After Intervention (No Accelerated Math Provided)	
		STAR Math Gains		
		← $\bar{X} = 2.64$ → (N = 76)		
		Matched NALT Gains*		
← $\bar{X} = 3.2$ (N = 33) →		← $\bar{X} = 5.75$ (N = 33) →		
		NALT Gains		
← $\bar{X} = 2.68$ (N = 65) →		← $\bar{X} = 5.51$ (N = 39) →		← $\bar{X} = 1.7$ (N = 7) →

*Performance of students for whom test scores exist on both measures across time.

in percentage of items passed on the MBST. Students who participated in Accelerated Math during the six-week summer intervention increased their performance on the math portion of the MBST by 9.6%. This gain was over five months (February 1998 to July 1998). After treatment, and with the treatment removed, they gained 6.4% on the math portion of the MBST that was administered in February 1999.

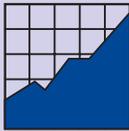
Discussion

We were interested in the extent to which use of a learning information system (Accelerated Math) would enhance the math performance of very low functioning students in an urban, mandatory summer school program. We investigated this under naturally occurring circumstances. One major finding was that the naturally occurring circumstances were incredibly difficult. Students who were required to attend summer school often were absent; some simply chose not to attend on certain days, or to leave in the middle of the day. Taking into account the number of days students were absent, they were taught math for about 16 days. Also, teachers assigned to teach math were not all math teachers. Only half of the teachers who chose to participate in this project attended the training session to show them how to use the learning information system. The other half had to be trained individually during class time.

Despite difficult teaching conditions, students equalled or surpassed previous educational gains in only 16 days of instruction. Overall, students gained more during the short summer school using a learning information system than they did in the nine-month academic year preceding the intervention. They also gained significantly more than they did during a nine-month non-treatment phase following the Accelerated Math interventions. We believe the gains can be attributed to the use of the learning information system that provided teachers with very specific information about student performance and progress on a daily basis. A learning information system such as Accelerated Math is a powerful intervention for improving the mathematics performance and skills of low achieving students in urban school districts.

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