

Gap Retention Analysis in a Trimester Schedule

The data was collected over a three-year period at Spring Lake High School. In this study I reviewed students' grades based on the sequence they followed for their core classes. (Biology, Algebra 1, U.S. History, Geometry, and English 9) Students' grades were reviewed based on did their **second term grade go down, up or stay the same**. Students whose grade went up or stayed the same were in one category and students whose grades went down were in another category.

The basic idea was to determine is there any performance change based on students taking the class sequentially or having a term gap in between instruction. Most people would believe that taking it sequentially would always be best.

| | Fall to Winter | Winter to Spring | Fall to Spring | |
|---------------------|-------------------|-------------------|-------------------|--|
| U.S. History | Grades Up or Same | Grades Up or Same | Grades Up or Same | |
| | 65% | 74% | 81% | |
| | Grades Down | Grades Down | Grades Down | |
| | 35% | 26% | 19% | |
| English 9 | Grades Up or Same | Grades Up or Same | Grades Up or Same | |
| | 59% | 83% | 68% | |
| | Grades Down | Grades Down | Grades Down | |
| | 41% | 17% | 32% | |
| English 10 | Grades Up or Same | Grades Up or Same | Grades Up or Same | |
| | 88% | 80% | 84% | |
| | Grades Down | Grades Down | Grades Down | |
| | 12% | 20% | 16% | |
| Biology | Grades Up or Same | Grades Up or Same | Grades Up or Same | |
| | 60% | 54% | 76% | |
| | Grades Down | Grades Down | Grades Down | |
| | 40% | 46% | 24% | |
| Geometry | Grades Up or Same | Grades Up or Same | Grades Up or Same | |
| | 63% | 55% | 60% | |
| | Grades Down | Grades Down | Grades Down | |
| | 37% | 45% | 40% | |
| Algebra 1 | Grades Up or Same | Grades Up or Same | Grades Up or Same | |
| | 34% | 45% | 40% | |
| | Grades Down | Grades Down | Grades Down | |
| | 66% | 55% | 60% | |

What we know about block scheduling and its effects on math instruction, part I

[National Association of Secondary School Principals. NASSP Bulletin, Feb 1997](#) by [Kramer, Steven L](#)

There are many reasons for adopting a block schedule. Research indicates that block scheduling may have important non-academic advantages, including a calmer school atmosphere, better discipline, and improved student attitudes. Intensive block schedules may be particularly helpful to at-risk students, reducing both failure and dropout rates. But how does it affect the teaching of mathematics?

During the 1990s, block scheduling has become increasingly popular in U.S. high schools. This two-part article is based on research conducted in response to math teachers' concerns about block scheduling. Often, math teachers are less than supportive of the move to a block schedule (Reid, 1995a; Usiskin, 1995), fearing the math curriculum will not fit well into longer time blocks. They are concerned about covering two lessons' worth of material during a double-length time block, perhaps reducing the amount of material students learn under a block schedule. The problem can be exacerbated at schools that offer more courses per year at the cost of allocating fewer minutes per course.

A second concern centers around gaps in sequential math instruction. A student might, for example, take algebra I in the fall of ninth grade, take no math at all for the next two semesters, and then take geometry or algebra II in the spring of tenth grade. This could result in the teacher needing to devote more class time to review. How can a math program operate most effectively under a block schedule? Is a block schedule worthwhile?

Background

The evaluation was based on a literature review, supplemented with published articles from a mix of sources. The author attended two sessions on block scheduling at the 1995 convention of the Maryland Council of Teachers of Mathematics; contacted a number of key researchers to clarify work they had done; and telephoned teachers and administrators involved in block scheduling across the United States and Canada. Many of the people interviewed identified additional information sources, both published and unpublished. Among the most important of these was an informal telephone survey of block scheduled schools conducted by administrators in Auburn, Ala., and a set of letters from teachers describing their experiences with block scheduling.

Research going back to the 1970s confirmed most of the non-academic benefits attributed to block scheduling. **Academic effects, on the other hand, were mixed.** Although lecturing appeared to be less effective in a block schedule, the assumption that this decreased effectiveness would cause teachers to rely more on participatory

modes of instruction was not supported-unless teachers were given adequate planning time and considerable staff development.

Math teachers' fears that they might cover less content after switching to a block schedule were supported, but the research also identified actions that could solve this problem. To work best under a block schedule, the math curriculum may need to be adapted to reduce redundancy between courses and to cover fewer topics in more depth within each course. In addition, math instruction should probably be spread over more courses during each student's high school career.

Definition

In block scheduling classes meet for a longer than traditional period of time daily but for fewer than the traditional number of days during the school year. The two primary types are "intensive" block scheduling and "alternating day" block scheduling.

The most common form is intensive block scheduling, one variation of which is the widely used "semestered" or "4 x 4" block schedule. In a semestered schedule, students attend four classes a day and complete each course in a semester. In other variations of intensive scheduling students might take three courses at a time with the year split into trimesters, or two courses at a time with the year split into four quarters.

The second most common form of block scheduling is the alternating day block, also called A/B scheduling. Under this system, a course meets every other day throughout the school year.

Some authors have used a different meaning of block scheduling, sometimes called interdisciplinary block scheduling, which combines two or more subjects into a single course, often team taught by one teacher from each subject area. This model has been used with considerable success, particularly in middle level schools (Sigurdson, 1982). Most of the interest among teachers and administrators is in single-subject block scheduling, however, and that is the type of schedule considered here.

Non-Academic Effects

School Atmosphere

There is strong anecdotal evidence that switching to an intensive or alternating-day block schedule has a positive effect on school atmosphere. Reid (1995b) noted the following changes after L. V. Rogers Secondary School began offering two courses at a time, four quarters per year: People who visited the school commented frequently on the relaxed but focused academic atmosphere. We expected some improvement in school climate

but were very pleasantly surprised by the extent of change. Although we anticipated a similar or slightly reduced number of discipline problems, we found discipline problems were virtually eliminated.

Similar effects on school atmosphere were reported at other schools with intensive block schedules (Carroll, 1994a; Hackmann, 1995; Meadows, 1995; Reid, 1995a; Sessoms, 1995) and at schools with alternating-day block schedules (Carroll, 1994a; Sessoms, 1995; Sturgis, 1995). Hillcrest High School (1995) also reported that students showed remarkable gains in self-esteem after the school switched to an alternating-day block schedule.

Hundley (1996) used the Classroom Environment Survey to compare the atmosphere in 30 block scheduled social studies classrooms to that in 30 traditional classrooms. He found large and statistically significant effect sizes in favor of block scheduled classrooms. Further analysis indicated that much of this effect was caused by positive changes in 12 of the 30 block scheduled classrooms where the teachers had received substantial training regarding instruction in a block schedule.

Student Discipline

A reduction in suspensions and/or discipline referrals goes hand-in-hand with improved school atmosphere at block scheduled schools. Four of five schools that addressed this issue in Carroll's (1994a) study reported reduced suspension rates, with reductions ranging from 25 to 75 percent. Reid (1995a), who interviewed principals at schools in British Columbia with an intensive quarter system, found that all five reported improved student behavior. Many other authors, writing about schools with both alternating-day and semestered block schedules, reported similar results (Hackmann, 1995; Hillcrest HS, 1995; Meadows, 1995; Sessoms, 1995.)

Some of the teachers and administrators interviewed attributed improved student behavior to the fact that students had fewer opportunities to get in trouble. Frequently, problems start in the hallway during passage between classes, and under a block schedule students spend less time each day passing through hallways.

Carroll (1994a) argues that improved behavior under a block schedule results from improved student/teacher relationships established during the longer class periods, and less stress on students dealing with fewer classes per day.

The literature reviewed indicates that pupil-teacher relationships sometimes, but not always, improve under a block schedule. Brophy (1978), Carroll (1994a), Reid (1995b), and Sessoms (1995) reported such improvements. Ross (1977) surveyed students and teachers from 22 schools with various schedule designs; 7 of the 22 were schools with semestered block schedules, and an additional 7 were all-year schools chosen as

matched controls for the semestered schools. (The other 8 schools were matched pairs of all-year "control" schools and schools with various other innovative schedules.)

The schools in Ross's study had not self-selected to report on the effectiveness of their programs. His findings indicate that changed use of instructional time acted as an important intervening variable. In those schools where teachers increased the variety of instructional strategies, allowed greater student involvement in classroom decision making, and increased student involvement in classroom activities, student-teacher relationships improved. Otherwise, they did not.

Ross's (1977) results are supported by those of Hundley (1996). On the Classroom Environment Scale, Hundley found that social studies students under a block schedule whose teachers had substantial training in modifying their instruction had significantly greater feelings of affiliation than students in traditionally scheduled classrooms. Social studies students in block scheduled classrooms whose teachers had minimal extra training did not have significantly greater feelings of affiliation than students in traditionally scheduled classrooms.

Attendance

Studies to date cannot confirm the claim made by some authors (e.g., King et al., 1975) that adopting a block schedule improves student attendance. Although two case studies (Cameron, 1995; Wasson HS, 1995) reported improvements, most others (Cox, 1995; Hatboro-Horsham SrHS, 1995; Meadows, 1995; Pulaski County HS, 1995) reported little if any change. Three multi-school studies (Carroll, 1994a; Reid, 1995a; Sessoms, 1995) showed improved attendance at some schools, decreased attendance at others, and no change at still others.

The literature indicated a 90 percent likelihood that schools switching to a block schedule will experience, on average, a change in attendance ranging between an increase of six days per student per year and a decrease of just under one day per student per year. More data will be needed before we can draw firm conclusions.

Student Attitudes

Both parents and students have been overwhelmingly positive about block scheduling at schools with **both alternating-day** and intensive block schedules (King et al., 1978; Hottenstein and Malatesta, 1993; Alam and Seick, 1994; Averett, 1994; Carroll, 1995a; Hillcrest HS, 1995; Meadows, 1995). Stevens (1976) provided a telling piece of evidence about student attitudes toward a block schedule organized in a semester format. He surveyed 25 eleventh graders and 66 twelfth graders who had transferred from non-semestered schools to semestered schools (Group S); he also surveyed 32 eleventh graders and 33 twelfth graders who had transferred from semestered schools to non-semestered schools (Group N-S).

His study presented the following results:

If you were to compare your experience with the semester and non-semester systems (trying to keep the systems separate from the schools, teachers, students, etc.), which system would you prefer?

Both the degree of satisfaction shown by the semestered students, and the fact that even the students in the non-semestered program preferred the semestered program are striking.

Teacher Attitudes

Often, faculty responses to a block schedule have been very positive. Some case studies of **alternating-day and intensive block** schedules are in line with this positive impression (Carroll, 1994a; Alam and Seick, 1994; Hillcrest HS, 1995; Meadows, 1995; Sessoms, 1995), as is the survey by Averett (1994). One school (Hatboro-Horsham SrHS, 1995) indicated that teachers, who had been split in their assessment of whether it would be a good idea to move to a semestered block schedule, became increasingly positive during the first two years of the program's implementation.

In other cases, teacher response to a block schedule has been less positive. Hackmann (1995) reported that **faculty morale had dropped**. Salvaterra and Adams (1995) reported two cases in which faculty support for a block schedule declined during three years of implementation. In one case, the schedule created significant division, with about a third of the faculty who initially opposed the change remaining opposed three years later.

Usiskin (1995) noted that math teachers, in particular, had mixed views about block scheduling. Stevens (1976) surveyed 200 teachers, 25 from each of eight semestered schools operating in Vancouver, B.C.; 76.7 percent of the teachers had previously taught in a non-semestered school. Although an overall majority of the teachers in his survey preferred a semestered schedule, **math teachers disagreed**.

A survey of nine semestered block scheduled schools in Ontario conducted by King et al. (1978) reported that 63 percent of math teachers and 58 percent of French teachers characterized a longer period as suitable for teaching their subject; in all other subject areas between 75 percent and 94 percent of teachers characterized the block schedule as suitable. An earlier summary of Canadian research noted, "In general, mathematics teachers are no more than tolerant of the longer period. Given a choice, most would rather work with the 40-minute period over a **full year**" (King et al., 1975, p. 39).

Two studies summarized teachers' (and students') responses when asked to list strong and weak points of a block schedule. Stevens (1976) addressed this point in British Columbia in the mid-1970s; Averett (1994) addressed this point in North Carolina in the mid-1990s.

Academic Effects of Block Scheduling

Failure Rates

The literature reviewed did **not** address failure rates at schools with **alternating-day block** schedules, so it is impossible to draw any conclusions about failure rates at such schools. In contrast, the literature provided good evidence that failure rates are likely to drop at schools that switch to intensive block schedules.

Five case studies (Hottenstein and Malatesta, 1993; Johnson HS, 1995; Schoenstein, 1995b; Reid, 1995b; Hackmann, 1995) reported decreases in failure rates at schools with a semestered or other intensive block schedule; none reported an increase. In addition, Reid (1995a) interviewed principals from five schools in British Columbia who had adopted an intensive schedule (two classes at a time, with each class lasting one-quarter of the school year). Failure rates dropped, often dramatically, in all five schools.

Dropout Rates

Usually, block scheduled schools have reported **lower dropout rates**. The few cases that reported an opposite trend had such low dropout rates to begin with that a decision to drop out by only a few students accounted for the change. Gov. Thomas Johnson High School (1995) reported an increase in dropouts from 1.6 percent to an average of 3 percent after switching to a block schedule, but noted that the reported dropouts were often students who had been on the rolls since the beginning of the year but never actually showed up at school.

Case studies indicating reduced dropout rates were reported by Carroll (1994a), Hottenstein and Malatesta (1993), Pulaski County High School (1995), and Reid (1995a). Often, the magnitude of improvement was substantial. Carroll reported that when Chelsea High School in Massachusetts switched to a trimester program, dropout rates went from 13.3 to 8.5 percent; when West Cateret HS in North Carolina adopted a "Macro Program" in which students took one core course at a time (each core course lasting one-fourth of the year), dropout rates fell from 11.3 to 4.7 percent. Reid reported that one school in British Columbia had difficulties because of a large and unexpected drop in rate: Students who had dropped out of school realized they could complete a course in one-quarter of a year under the school's intensive schedule and returned to finish the courses they needed to graduate!

Two of the studies reviewed compared the dropout rate in Ontario's semestered schools to that in Ontario's traditional schools. They came to opposing conclusions, but the more valid of the two found that dropout rates were lower in the semestered schools. King et al. (1978) found that the amount of decline in enrollment between September and May in nine semestered schools was similar to but greater than the average decline in enrollment described by three Ontario school districts. From this, they concluded that claims of reduced dropout rates in semestered schools were unsupported.

Sharman (1990) tracked students from tenth grade through the end of high school, in a large sample of block scheduled and matched traditional schools, noting whether each student transferred, graduated, or dropped out. He found that students from the semestered schools had a significantly lower dropout rate.

In only one case did a school with an alternating-day block schedule report a decreased dropout rate (Carroll, 1994). It appears that intensive block schedules are likely to reduce dropout rates, but it is unclear whether **alternating-day block** schedules have the same effect.

Decrease in Failure and Dropout Rates

Modified Courses

Some teachers interviewed for this study described new courses (e.g., a two-part algebra course) that had been designed to help low-achieving students. Although such an adjustment is possible under both alternating-day and intensive block schedules, scheduling multiple-part math courses is more convenient if a school adopts an intensive model.

Fewer Courses at a Time

A different explanation for decreased failure rates applies only to intensive block schedules. Carroll (1994a) theorized that one way an intensive block schedule could improve student performance was by enabling them to focus on fewer courses at a time. Teachers responding to Averett's (1994) survey agreed with this assessment. Reid (1995a) reported that students, especially weaker ones, were able to organize better when concentrating only on two subjects and teaching styles.

Opportunities To Retake Failed Courses

As one teacher put it, there is more "forgiveness" in an intensive block schedule. Student who fail a class can retake it the next semester and catch up with their age-mates. The opportunity to retake failed classes was one

reason students gave for preferring semesters to all-year classes (Stevens, 1976). Reports confirm that students do take advantage of this opportunity.

Advanced Placement Classes

In some cases, schools have adjusted to AP exam schedules by holding AP courses as double-length courses that run the entire year (Edwards, 1995; Johnson HS, 1995) or three-quarters of the year (Schoenstein, 1995a), with the last quarter perhaps offering a special topic such as a probability/statistics class. One article described a block scheduled school that switched its AP courses back to standard 45-minute classes. For example, AP English and AP social studies ran **in back-to-back 45-minute classes** for the entire school year. The authors noted, however, that several teachers thought this was a step backward (Salvaterra and Adams, 1995).

The Auburn telephone survey indicated that some schools adjusted the block schedule to accommodate AP classes. One school they surveyed held AP classes in the fall semester and offered an AP seminar in the spring; five schools held block-length AP classes either all year or for three-quarters of the year; and five schools felt they were doing fine with no accommodation of their block schedule.

Grades

Student grades improve at most block scheduled schools. Eleven of the 13 block scheduled schools responding to the Auburn survey reported improved grades; the other two indicated no change. Case studies have supported this finding (Carroll, 1994a; Reid, 1994, 1995a; Pulaski County HS, 1995), as did a literature review by King et al. (1975).

It is **not certain that improved student grades reflect increased learning**, particularly if in some classes students cover less material under a block schedule. King et al. (1975) and Gore (1995) presented data indicating that improved grades under a block schedule may be the result of grade inflation, and thus not a valid measure of academic achievement.

Test Scores

Alternating-day block schedules. At present, too little information is available to draw conclusions about the effects of an alternating-day block schedule on student achievement test scores. Only four schools with alternating-day block schedules reported testing results. Two reported improvement, one reported no change, and one reported a decrease after switching to the block schedule (Cameron, 1995; Hillcrest HS, 1995; Sessoms, 1995; Sturgis, 1995).

Achievement under an intensive block schedule. Nine individual schools using intensive block scheduling reported results of achievement tests. Five showed improvement (Sessoms, 1995; Carroll, 1994a; Reid, 1995a; Salvaterra and Adams, 1995); three showed little or no change (Carroll, 1994a; Lockwood, 1995; Pulaski County HS, 1995), and one showed a slight decrease in test scores (Hatboro-Horsham SrHS, 1995).

Meadows (1995) investigated four schools in Frederick County, Md., that adopted a semestered block schedule in 1992 or 1993. She reported that after adopting a block schedule, there was no significant change in the percent of students at these schools receiving 80 percent or better in summative finals in English or math.

A number of studies have investigated the effects of semestered block scheduling in Ontario. The two biggest (Raphael and Wahlstrom, 1986; Raphael, Wahlstrom, and McLean, 1986) used data from the Second International Science Study (SISS) and the Second International Math Study (SIMS) to compare achievement of students enrolled in semestered programs to students enrolled in all-year programs. Students enrolled in biology, chemistry, physics, **grade 12 mathematics**, or grade 13 mathematics were tested. (In Ontario, grade 13 is an optional grade for students who intend to go to college.)

In every subject area tested, all-year students achieved higher mean scores than semestered students, with statistically significant differences in **grade 12** math and for grade **13 math** specialists. However, these studies can be criticized on several grounds. Data were collected before the end of the semester, so that semestered students had completed a smaller percentage of their coursework than had non-semestered students. More important, there is reason to believe that lower-ability students were more likely to be enrolled in the semestered than in the non-semestered classes. As noted above, semestered schools appear to have a lower dropout rate than do non-semestered. Also, there is evidence that students in schools with intensive block schedules are more likely to enroll in challenging math courses than are students in schools with traditional schedules (Reid, 1995a, 1995b). It is possible that Raphael's results were due to a positive effect of the block schedule (i.e., lower ability students taking more math courses) rather than to a negative effect.

Other studies in Ontario investigating younger students (grades 9 and 10) found that block scheduling had no effect on achievement. Stennett (1985) found no achievement differences between students in London, Ontario, who took **grade 9** general level math under a semestered schedule and those who took it under an all-year schedule. Similarly, Stennett and Rachar (1973) and Smythe, Stennett, and Rachar (1974) reported no difference in achievement among students in London, Ontario, who took grade 10 mathematics during the first semester, the second semester, or in an all-year program.

According to Ontario's Ministry of Education and Training, the Technical Report for the Grade 9 Reading Test 199394 will provide evidence that reading scores are the same in both traditional and semestered schools in Ontario. Because the test was given two years in a row, with more than 130,000 students participating, these data are likely to provide strong evidence that, as implemented in Ontario, a block schedule had neither positive nor negative effects on tested reading achievement.

At this time, it is not clear whether the differences among studies of block scheduling in Ontario are the result of students experiencing a cumulative negative effect (at least in math and science) that does not appear in younger grades; the result of a differential filtering (at least in math and science) that causes lower-ability students in all-year schools to drop out of challenging courses by grades 12 and 13; or the result of random variations in testing. A clearer picture will be possible when data from the Third International Mathematics Science Study (TIMSS), which was released November 20, 1996, have been analyzed, because the TIMSS (unlike SISS and SIMS) sampled all upper grade students, not just those who chose to enroll in challenging math and science classes.

The best achievement data currently available come from North Carolina and British Columbia. Semestered block scheduling appears to have had an overall positive effect in North Carolina. In contrast, semestered and quarter plan block scheduling appear to have had a negative effect on math and science achievement in British Columbia.

Averett¹ (1994) summarized the change in test scores at a large number of schools in North Carolina that switched from a traditional schedule in 1992-93 to a semestered block schedule in 1993-94. Standardized end-of-course tests were given in five subjects: algebra II, geometry, English I, U.S. history, and economic, legal, and political systems (ELP). The number of schools reporting results ranged from 21 for algebra II (with more than 2,000 students tested each year) to 27 for English I (with more than 5,500 students tested each year). In these five subject areas, the average change in final test scores was small, ranging from -0.4 percent to +1.5 percent, compared to a standard deviation of 16.6 percent or greater on each test. During the same period the statewide average test score decreased slightly in all five subject areas.

Overall, Averett's (1994) data seem to indicate that switching to a semestered block schedule had either no effect or a slightly positive effect on achievement in these five subject areas. This is true despite the fact that allocated clock hours under the block schedule were only 135, vs. allocated clock hours under the traditional schedule of between 150 and 165 (depending on the school). Also, teachers may have been operating at a disadvantage in teaching the block scheduled classes, since they were in the first year of implementing the new schedule. Thus, Averett's results overall reflect quite favorably on the block schedule.

In sharp contrast, Bateson's (1990) study of **science** achievement in British Columbia's semestered schools reported valid and strongly negative results. He reported results of a matrix-style test administered in 1986 to all tenth graders. Of the 30,116 students tested, 64.9 percent took science in an all-year format, 28.3 percent took science in a semestered format, and the remaining 6.8 percent either did not take science in 1986 or were in another type of timetable.

(Note that students could not be "filtered" out of the testing if they failed to enroll in academic classes, and that **few students are likely to have dropped out of school by tenth grade**. Thus, there is no reason to believe that the population of students tested in semestered schools were of lower ability than the population of students tested in all-year schools.)

Students in traditional schools scored significantly better than students in semestered schools in all six areas tested. Contrary to expectations, the difference favoring traditionally taught students was strongest in the area labeled "**rational and critical thinking**." Followup conversations with Bateson indicate that students in traditional schools outscored those in semestered schools in all 120 test questions!

Marshall et al. (1995) reported data from British Columbia's 1995 **Mathematics and Science Assessment** that replicated Bateson's (1990) results, and extended them to British Columbia math students. There were 29,183 students who took the grade 10 science test, of whom 64 percent studied science under an all-year (10-month) schedule; 28 percent studied under a semestered block schedule; and 8 percent studied under a quarter plan block schedule. There were 24,520 students who took the grade 10 math test, of whom 67 percent studied under an all-year schedule; 26 percent studied under a semestered block schedule; and 7 percent studied under a quarter plan block schedule. In both subject areas, **all-year students scored higher** than semestered students, who in turn scored higher than quarter plan students.

Results were not quite as strong as Bateson's (1990): In science, all-year students scored highest on 69 of the 80 items, semestered students scored highest on 14 items, and quarter students scored highest on 7. In **math**, all-year students scored highest on 74 of the 80 items, semestered students scored highest on 3 items, and quarter students also scored highest on 3 items.

One key **limitation** to Marshall et al.'s study is timing of the assessment. All students were tested in May 1995. (Bateson's study reported data that had been collected closer to the end of the year.) Students had not yet completed the course, and those taking coursework in the second semester or in the fourth quarter had yet to finish, respectively, twice or four times as much content as those studying in the all-year format. The following overall pattern of scoring somewhat mitigates this limitation, however. According to Bateson (1990) top scorers

were always the all-year students, followed by first-semester students, then second-semester students, then by third-quarter students (who had recently completed the entire course), then by first-quarter students, then by second-quarter students, and last by fourth-quarter students (who were probably the most strongly affected by not having completed the class). If timing of the test were the sole explanation for observed differences, then third-quarter students would have been expected to outscore semesters and perhaps all-year students.

A **second limitation** to the two studies is a possible volunteer effect. Schools elected which timetable to adopt, and it is possible that variables such as prior student performance could have caused them to make the change to a block schedule and in turn could account for the differences reported. Despite these limitations, Bateson's (1990) and Marshall et al.'s (1995) results are sufficiently striking to demand an explanation.

What went wrong in science and math classes in British Columbia's block scheduled schools? This question will be addressed in **Part 2** of this article.

Instructional Changes Under a Longer Time Block

King et al. (1978) conducted a detailed survey in 26 Ontario schools, including 9 with a semestered block schedule, supplementing their survey with in-depth case studies at 6 of the schools with semestered blocks and 2 of the schools with other schedules. They came to the following conclusions regarding instruction under a block schedule:

Some teachers have made very little adjustments in their teaching methods in the longer period while others have made major curricular and methodological changes. Those that have made adjustments appear to be far more successful in making the learning experience more rewarding for students. It appears necessary to exchange some of the content normally covered in the past for a more in-depth study of major themes and skills to extract the greatest benefit from full-credit semestering (King et al., p. 45).

Recent research confirms their conclusions. These conclusions may be particularly applicable to math instruction.

Reduced Effectiveness of Lecturing

There is a clear consensus that maintaining a pure direct instruction/lecture mode of instruction does not work as well in a longer time block. Students find it difficult to sit through two lectures in a row. This is reflected in published literature (King et al., 1975; Canady and Rettig, 1994; Meadows, 1995; O'Neil, 1995; Reid, 1995a), and in case studies (Howard HS, 1994). Both workshops the author attended at the MCTM conference emphasized a need to reduce the amount of lecturing when a school switches to a block schedule. Several of the

math teachers interviewed also indicated a **need to reduce lecturing** under a block schedule. Several sources mentioned they try to have at least three different activities during a 90-minute period.

The need to adopt new teaching modes is reflected in a comment made both in interviews and in published sources (Averett, 1994; Meadows, 1995): Experienced teachers said they "felt like first year teachers" after switching to a block schedule. A Canadian study (Raphael et al., 1986) found that although in all-year science classes a teacher's experience correlated with his or her students' performance, in semestered schools greater teaching experience did not predict greater student success. Pedagogical methods that teachers learned from experience in traditional classrooms do not seem to translate successfully into block scheduled classrooms.

Effects on Breadth and Depth of Content Coverage.

The evidence seems to indicate that, under both alternating-day and intensive block schedules, teachers cover less information but in more depth (King et al., 1978). This is what one would expect if teachers are changing to more participatory teaching processes (Seely, 1995). Unfortunately, teachers who primarily use a lecture mode under a block schedule may cover less material without increasing their depth of coverage (Bateson, 1990; Usiskin, 1995).

Breadth of coverage. Survey and anecdotal data provide consistent evidence that teachers often cover less material under a block schedule (Brophy, 1978; King et al., 1978; O'Neil, 1995; Sturgis, 1995). Math teachers seem to be particularly likely to cover less material (Evans, 1972; Usiskin, 1995).

The reports of decreased coverage may come primarily from schools that offer more courses per year with fewer hours allocated per course. However, a literature review by King et al. (1975) reported that both math and French teachers experienced particular difficulty covering the equivalent of two classes of material during a double length period. In a followup study, King et al. (1978) made detailed observations of classrooms in six block scheduled schools. Comparing math classrooms in these schools to ones they had observed operating under a traditional schedule, they noted that under a block schedule math teachers frequently used up more instructional time to cover the same content.

Depth of coverage. Studies from schools with both intensive and alternating-day block schedules support King et al.'s (1978) claim that, under such schedules, teachers can cover material in more depth. Carroll (1994a) described a detailed evaluation of a block-scheduled program at Masconomet (Mass.) High School that concluded students developed deeper understanding under an intensive block schedule. Averett (1994) reported teachers and students surveyed in North Carolina's block scheduled schools felt longer class periods allowed more in-depth instruction. Meadows (1995) reported similar results at semestered block scheduled schools in Frederick County,

Md. Sessoms (1995) and Sturgis (1995) reported cases in which teachers felt they could cover material in more depth under an alternating-day block schedule. One study (Stevens, 1976) disagreed with the general result that block scheduled classes address topics in more depth, but most of the evidence indicates that they do.

Supporting Effective Instruction Under Longer Time Blocks

Changes to Pedagogy Are Not Guaranteed

Unfortunately, as King et al. (1978) noted, creating a situation in which old methods do not work as well does not necessarily mean that new methods will be adopted. In general, research into school restructuring indicates that structural change alone, without additional support, does not lead to changes in instruction (Newmann and Wehlage, 1995). Switching to a block schedule can act as a catalyst for changed teaching methods, but does not guarantee the change (Canady and Rettig, 1995; O'Neil, 1995; Salvaterra and Adams, 1995).

Although surveys (Ross, 1977; Brophy, 1978; Averett, 1994) and case studies (Harter, 1994; Hillcrest HS, 1995; Meadows, 1995; Sessoms, 1995) indicate that, in general, teachers at block scheduled schools use less lecture and more participatory teaching processes, this change may be **more difficult for math** than for other departments. Reid (1995a) interviewed five principals of schools in British Columbia that had switched to an intensive (4 quarters, 2 courses per quarter) block schedule, and found that math teachers in these schools had a harder time changing their teaching methods than did those in other departments.

In another Canadian study, King et al. (1978) found that in semestered schools math students spent a larger percentage of their time taking tests, doing seatwork, or listening to the teacher than students in any other subject. **Ninth and tenth grade** math students in their study spent 97.3 percent of their time in these three activities; upper grade math students engaged in them for 90.3 percent of the time. Preliminary results from a study being done in the United States (Muruyama et al., 1995), although they are less dramatic, also show a trend for math teachers in a block schedule to adopt a less participatory mode than other teachers.

These results are certainly not universal. The overwhelming majority of math teachers interviewed for this study who had moved to a block schedule said they had changed their teaching processes. However, it is critical that schools moving to a block schedule provide sufficient support for teachers-particularly math teachers-to adopt teaching methods appropriate to the longer time blocks.

Staff Development

Several teachers and administrators stated that staff development had been crucial to making block scheduling successful at their school. One teacher described attending a math workshop that included teachers from a school that adopted a block schedule after extensive inservice training, as well as teachers from another school that adopted a block schedule without the training. The teachers from the school with training were very positive about the block schedule; the ones from the school **without the training were very negative.**

A math teacher in Colorado emphasized the importance of finding other schools to use as models when moving to a block schedule. Although Brophy (1978) reported that teachers she surveyed at four semestered schools felt they needed little inservice training, King et al. (1978) found that staff members were more satisfied with the change to a block schedule at those schools where they had been involved in staff development activities. North Carolina teachers and administrators emphasized that staff development was one key to successful implementation of block scheduling (Averett, 1994).

Salvaterra and Adams (1995) described a school at which support for block scheduling started to ebb in the second year. They attributed this in part to a new principal who provided no staff development at a time when teachers were finding it difficult to develop creative ways to present lessons during 90-minute class periods.

Hundley (1996) studied 30 social studies teachers from block scheduled schools, 12 of whom had had substantial staff development to support the switch to the new schedule. Using the Classroom Environmental Survey, he found large and statistically significant differences in classroom environment in favor of the teachers who had received the staff development.

Perhaps the last word on staff development should be left to Canady and Rettig, who are among the nation's **strongest advocates of block scheduling:**

We urge school personnel NOT to move to any form of block scheduling if teachers are not provided with a minimum of 5, and hopefully 10 days, of staff development (1995, p. 205).

Planning Time

Allowing sufficient planning time may be even more important than providing staff development. All five principals interviewed by Reid (1995a) noted that the uneven distribution of planning time in the model they used (large blocks of time in some quarters, with no planning time at all in other quarters) was a significant problem in adopting a block schedule. Brophy (1978) found that teachers in semestered schools often spent more than twice as much time planning as teachers in all-year schools. Salvaterra and Adams (1995) described a rural high school in the United States that switched to an intensive schedule offering two classes at a time in a quarter

system: Teachers were frustrated because planning for the longer periods took significantly more of their personal time.

Teachers interviewed for this article agreed they needed increased planning time: "It's a lot of work; it's almost like your first year all over again." Averett (1994) reported a nearly identical response from teachers and administrators surveyed in North Carolina, as did Meadows (1995), describing the responses of teachers in Maryland.

Adequate teacher planning time may be particularly critical during the first few years after a school has adopted a block schedule. In general, it is likely that adapting to any major change in school operations requires teachers to spend additional time planning. Watts and Castle (1992), citing their experience working with more than 100 school restructuring efforts associated with the National Education Association's National Center for Innovation, concluded that sufficient teacher planning time was a fundamental aspect of successful innovation.

The other two studies indicate that decreasing class size may not improve high school math achievement. Hedges and Stock (1983) have provided the best meta-analysis to date on general effects of class size on achievement. Their figures show that, unless class size is reduced to fewer than 20, achievement benefits are likely to be minimal.

Robinson and Wittebols (Nishi, 1990) provided evidence that reducing class size may be particularly ineffective in high school math classes. In an extensive review of the literature, they found only seven studies investigating the effect of class size on high school math. Five of the studies showed no significant difference between large and small classes; the other two actually showed better achievement in the larger classes!

(Although Robinson and Wittebols' review does cast doubt on the assumption that reducing class size will improve high school math achievement, one should be careful not to overgeneralize their findings. It is reasonable to hypothesize, for example, that reducing class size might make little difference in a math class taught via 45 minutes of lecture, but might provide major benefits in a class taught via 90 minutes of small group problem solving. This hypothesis would certainly merit testing.)

Taken together, these studies indicate that even without making a major structural change, high school math classes are more likely to benefit from increased planning time than from reduced class size. When math teachers are coping with the additional planning demands created by a block schedule, preserving (or increasing) planning time becomes even more important.

Among the math teachers who were satisfied with the change to a block schedule, the overwhelming majority were at schools that had adjusted the curriculum. Curriculum adjustments were made to take advantage of the opportunity for more math instruction at schools where students who had previously taken six or seven courses per year were now taking eight courses per year, and to make up for less breadth of coverage within each individual math course.

Opportunities for more math enrollment. Administrators often move to a block schedule to enable students to take a larger number of courses each year. A school that had previously offered students seven 50-minute periods daily might move to a schedule that offered students four 90-minute periods daily. Under an intensive block schedule, each course would then meet for half the year, while under an alternating-day block schedule, each course would meet every other day. In either case, students would replace two 50-minute periods with one 90-minute period, but would take one extra course yearly.

Under this type of schedule, students often enroll in a larger number of core courses (Cameron, 1995), and in particular a larger number of math classes (Edwards, 1995). One math teacher indicated that students enrolling in additional math courses were of two types: students who had failed a class and were retaking it, and top math students who were taking two math courses a year. Teachers interviewed reported accommodating their students by offering new math courses. They might offer two-semester algebra or special help classes for those having trouble; they might offer statistics and honors math for those seeking enrichment.

Harter (1994) noted this kind of schedule allows schools to offer students more time to take math, not less. He emphasized that students unlikely to succeed within existing time constraints could benefit from two-term core math courses, that honors programs could offer two semesters of challenging math yearly to interested students, and that all students could benefit from courses in statistics and data analysis.

Administrative constraints can make it impossible for schools to take advantage of this opportunity. Harter (1994) reported that principals in North Carolina's block scheduled schools were often allotted faculty slots within distinct classifications (i.e., so many math teachers, so many science teachers, so many art teachers) and these allotments could result in an imbalance between student needs and faculty members available to teach particular courses.

According to Harter, this resulted in many schools with semestered block schedules encouraging students to take elective courses outside the core disciplines, while discouraging or even denying some students access to two courses per year in the same academic discipline. He concluded that the potential advantages of a block schedule could be fully realized only if principals were given more flexibility in assigning teaching positions.

Curriculum adjustment within courses. In the literature reviewed, three studies (King et al., 1975; Harter, 1994; Sessoms, 1995) noted that math teachers need to adjust the curriculum under a block schedule. Some schools have eliminated redundancy between the algebra I and algebra II curricula. Others have modified the standard sequence by adding a new math course (e.g., replacing algebra I and II with algebra A, B, and C; or taking some content out of earlier courses and putting it into a new algebra/trigonometry course offered as a prerequisite to calculus). They reported these changes had solved the problem of less breadth of coverage, while enabling them to increase depth. A good example of the potential importance of reworking curriculum while moving to a block schedule is the following description, contained in a letter from a math teacher in a school with an intensive block schedule:

Our school is in its third year of using the block schedule where students complete one course in 18 weeks. **The only problem we had was with algebra.** All of the other courses were easily adapted to the 85-minute class, but algebra in 18 weeks is just too fast. We met with such failure the first year that our administration readily went along with changing algebra to a full-year class (36 weeks). Algebra is the foundation of all of our other classes and the students need to have a solid foundation before we can expect them to succeed in following courses. The full-year classes in algebra allow plenty of time to do the exploration and hands-on activities that help the students get a better understanding. In the 18-week algebra, it was practically impossible to do any activities—we felt like we were flying through the material and losing lots of students in the process. There's not a lot of algebra that can be dropped (chopped, condensed, combined, etc.) without adversely affecting future courses.

Since changing to 36 weeks of 85 minutes of algebra each day, we have had a much better success rate and the geometry and algebra II teachers have noticed a difference.

Adjusting the math curriculum takes time that is often unavailable to math teachers during the regular school year. Principals switching to a block schedule may want to consider funding summer-time workshops at which math teachers can meet and plan the necessary changes.

1. Averett's report provided only raw scores for block scheduled schools during the two years. This author converted Averett's scores to percentages using number of items per test, as provided by Ellie Sanford, North Carolina Department of Public Instruction. Sanford also provided normed standard deviations, as well as statewide averages for each test in each year.

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