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The Effects of Full and Alternative Day Block Scheduling on Language Arts and Science Achievement in a Junior High School

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Abstract

The effects of a full (4 X 4) block scheduling program and an alternate day (AB) block scheduling program in a junior high

school were under investigation in this study through the use of an *ex post facto*, matched sampling design. Measures investigated were standardized achievement tests in science and language arts. Both forms of block scheduling had been in place for several years, and one teacher in science and one teacher in language arts had taught students under both forms of scheduling. Because the sampling designs and analyses were different for the science and the language arts areas, two studies are reported here—each examining the effects of 4 x 4, AB, and traditional scheduling with attribute variables of gender and student skill levels in each analysis. Results consistently show students in both forms of block scheduling outperforming students in traditional scheduling, and that AB block scheduling has the largest positive impact on low-achieving students.

Defined as 90 – 120 minute class periods versus the traditional 45 – 55 minute class period, block scheduling is one of the fastest growing educational reform initiatives in secondary public education during the last two decades. Although block scheduling has been a viable scheduling choice for many schools for over forty years, it was not until the late 1980s that block scheduling became more widespread throughout secondary schools in the United States. The growth in block scheduling was a reaction to the notion that “close, personal relationships among students and teachers had become less likely in traditional environments as student numbers and student-teacher ratios increased” (Nichols, 2000, p. 135). As of 1995, Canady and Rettig estimated that 50% of American high schools had implemented some form of block scheduling, with some states (e.g., North Carolina, Virginia) having much higher rates.

In the literature, block scheduling first appeared as modular scheduling, flexible scheduling, or modular flexible scheduling (Stewart & Shank, 1971; Wood, 1970). Accordingly, block scheduling can be implemented in many different ways with numerous modifications, often called “hybrids” in current literature. Whether called an intensive block, 4 x 4 block, AB plan, or modified block—all types of block scheduling have the commonality of increasing the time available for instruction by extending classes beyond the traditional 50-minute class (Weller & McLeskey, 2000).

Full Block (4 x 4) Semester Plan

The most popular method of block scheduling is the 4 x 4 semester plan, also known as “Accelerated Schedule” or “Copernican.” In a 4 x 4 semester plan, students attend the same four 90-minute classes every day of the week. By attending each class every day, a student can complete four yearlong equivalent courses in one semester, although the amount of time spent in the course may be slightly less than in traditional scheduling (Queen, Algozzine, & Eddy, 1997). The plan offers teachers a manageable timetable, as they teach three classes with a daily planning period rather than five or six classes with a planning period every other day (Edwards, 1995).

Many researchers have explored student, teacher, and administrator perceptions of the 4 x 4 semester plan. Specifically, researchers have offered

findings on classroom climate, instructional approaches, student/teacher relationships, and overall satisfaction with block scheduling. As for perceptions regarding the overall effectiveness of the 4 x 4 semester plan, parents have consistently perceived improvement in the academic and social outcomes of students participating in a block scheduling format (Eineder & Bishop, 1997; Thomas & O'Connell, 1997a). As for teachers, Edwards (1995) found that after one semester with a 4 x 4 schedule, they reported significant improvements in teaching effectiveness. Staunton (1997) found that teachers with five or more years of teaching in the 4 x 4 semester plan had significantly higher perceived ratings of assessment techniques than did teachers in a traditional scheduling environment. In a survey of four 4 x 4 block scheduling programs, Wilson and Stokes (2000) found that, overall and over time, students perceived block scheduling to be an effective approach, especially if they thought that teachers used a greater variety of teaching strategies in class. Thomas and O'Connell (1997b) found that students felt 4 x4 block classes offered fewer chances to cheat and increased fairness in grading. Additionally, Edwards (1995) found that a majority of students found it easier to focus on assignments and understand the lessons better.

As for class size and classroom climate, two recent studies have found that teachers perceived an increase in class size with 4 x 4 semester plan scheduling (Limback & Jewell, 1998; Moore, Kirby, & Becton, 1997). However, Wilson and Stokes (2000) found that students perceived the 4 x 4 semester plan to offer a better instructional environment than in traditional scheduling (e.g., teachers get to know them better, greater variety of instruction). In addition, teachers perceived student/teacher relations to be better with 4 x 4 semester plan as there was more time for concentrated interactions (Eineder & Bishop, 1997; Skrobarcek et al., 1997; Thomas & O'Connell, 1997b). O' Neill (1995) also argued that discipline problems have dropped at many of the schools using block schedules because of this enhanced climate. These findings suggest that the 4 x 4 semester plan format may increase the number of students per class while creating a more productive learning environment.

The 4 x 4 semester plan is designed to create a new and different teaching and learning experience for students and teachers. Staunton (1997) found that teachers with more years of experience were significantly more satisfied with instruction in 4 x 4 semester plan scheduling than in traditional scheduling. However, Baker and Bowman (2000) found that teachers with less experience were more likely to view block scheduling positively than were more experienced teachers, as they appeared more willing to make the necessary instructional changes. Using direct observations and in-depth interviews, Queen, Algozzine, and Eddy (1997), found that teachers appreciated the flexibility in classroom instruction, longer planning periods, greater course offerings, and more time for in-depth study that block scheduling provided.

Alternate Day Block (AB) Plan

The Alternate Day Plan for block scheduling is also known as AB, Odd/Even, and Day 1/Day 2 respectively. With AB scheduling, students take three or four 90-120 minute classes on alternating days for an entire school year. Many school districts have found this mode of block scheduling conducive to school

environments versus the 4 x 4 block schedule and the traditional 45-55 minute class schedule.

The research literature much more sparse on AB scheduling. However, Buchman, King, and Ryan (1995) found that both scheduling formats produced very positive perceptions regarding the impact of AB block scheduling on safety, success, involvement, commitment, interpersonal competency, and satisfaction. According to Payne and Jordan's (1996) study on the instructional impact of AB block scheduling, "teachers reported that they enjoyed having more time to give students individual assistance; opportunities to get to know the students personally; time for more creative and meaningful student work; and the ability to structure a full lesson" (p. 18). Thus, these advantages of an 85-minute block period led to a less stressful and more flexible classroom climate (Payne & Jordan, 1996; Weller & McLeskey, 2000). As a result, supportive teachers working under this type of block scheduling develop curricula focused on cooperative learning exercises to take advantage of the longer blocks of time (Weller & McLeskey, 2000). Payne and Jordan (1996) also found that teachers were positive about the way classes were scheduled, staff development, and planning time afforded by an AB schedule.

As for the impact on learning Payne and Jordan (1996) did not find significant differences in students' perceptions regarding the efficacy of the AB scheduling plan as compared with traditional scheduling. On the downside, Payne and Jordan (1996) found that teachers reported needing more resources for varying instruction and more time for planning. Shortt and Thayer (1995) found that teachers believed that students needed instruction in a subject every day to maximize the learning process.

4 x 4 Semester Plan and AB Plan Compared

As many school districts look to take on some form of block scheduling, it is necessary to look at literature for analysis of which block scheduling option seems most favorable by students, teachers, and administrators. The majority of the literature on these two forms of block scheduling has focused on the following characteristics: student grades, class size, classroom climate, time issues, instruction, and dropout and attendance rates.

Pisapia and Westfall (1997a; 1997b) found that teachers in the 4 x 4 semester plan were more satisfied with students' grades than were teachers in AB schedule. However Hamdy and Urich (1998) explored teachers' perceptions of class size and classroom climate in both block scheduling formats compared with traditional scheduling and found teachers did not think class size was reduced with block schedules nor was classroom climate perceived more favorably with either block schedule formats.

The way class time is used has also been an important factor in implementing either 4 x 4 semester plan or AB block plans. Teachers often perceived a greater need to change the pace and type of instruction (e.g., group learning) with both the 4 x 4 semester plan and AB plans (Pisapia & Westfall, 1997b; Swope, Fritz, & Goins, 1998).

Research has also shown mixed findings in attendance and dropout rates for students in both the 4 x 4 semester and AB plans. Pisapia & Westfall (1997a, 1997c) found that teachers perceive better attendance with the 4 x 4 semester plan than with the AB plan. Conversely, other studies show no reduction in dropouts or increased attendance with either the 4 x 4 semester or AB plans as compared to traditional scheduling (e.g., Skrobarcek et al., 1997).

As for overall satisfaction, students in the 4 x 4 semester plan were found to be more satisfied with the number of courses available for them in which to enroll than both students in AB plan and in traditional scheduling (Pisapia & Westfall, 1997b). According to Lapkin, Harley, and Hart (1997), three-quarters of students believed that the longer periods in both the 4 x 4 semester and AB plans made it easier to speak French and to interact with the teacher. However, a similar majority of students reported being more tired, less attentive, and more bored in the longer French periods as compared with the shorter classes in traditional scheduling plans.

Conclusion

It is difficult to produce any consistent conclusions from the recently published literature on block scheduling as most researchers disagree about the positive and negative effects of 4 x 4 semester plan and AB scheduling. However, there are certain advantages and disadvantages to block scheduling that have been identified through both quantitative and qualitative research on the subject.

Advantages

Overall, the research provides modest support for the presumed advantages of block scheduling (Payne & Jordan, 1996). According to Lapkin et al. (1997), block scheduling may promote higher levels of reading and writing proficiency. Students participating in block scheduling plans are also appear to show greater gains in grade point average as compared with traditional instructional formats (Edwards, 1995). Nichols (2000) concluded that longer class periods encourage teachers to develop more effective behavioral management techniques rather than relying on administrative disciplinarians. In addition, Nichols (2000) argued that the decrease in quantitative minutes of classroom instruction is more than offset in the quality of student-teacher interaction in a block scheduling format.

Disadvantages

Adopting a block schedule has its disadvantages, especially around designing instruction appropriate for the longer classes (O'Neill, 1995). Additionally, although time is extended on a daily basis for all types of block scheduling, the actual class time may actually drop around ten percent (Queen et al., 1997). As a result, some teachers will inevitably cover less material because of the reduced number of total instructional minutes (O'Neill, 1995). Advocates of Advancement Placement programs have also expressed concerns about the preparation of students who take fall class and spring exams (O'Neill, 1995), a

concern associated with 4 x 4 block scheduling in particular. In addition to concerns about the scheduling of advanced placement courses, the sequencing of foreign language and music are also challenges to the block scheduling format (Shortt & Thayer, 1995).

Furthermore, there are concerns about the effectiveness of block scheduling for all student populations. Specifically, transfer students and lower-achieving students may not garner the same benefits as the other students because of the faster pace and tighter structure of block scheduling (Nichols, 2000; Shortt & Thayer, 1995). These students may actually experience lower levels of achievement and success “in schools where block scheduling was poorly planned for and quickly implemented” (Nichols, 2000, p. 145). Students may also have difficulty in keeping track of their books, due dates for assignments, and when quizzes and exams are scheduled (Weller & McLeskey, 2000). In addition, “absences are magnified within the block schedule because of the time between class periods and because there is limited time within the schedule for students to contact teachers to see what work they have missed” (Weller & McLeskey, 2000, p. 215). Thus, “students who miss class or do not keep up with their studies are more likely to fail” (Edwards, 1995, p. 27).

Finally, Shortt and Thayer (1995) concluded that academic pacing is a concern when switching to block scheduling, as teachers may struggle with meeting instructional objectives and curriculum standards. According to Queen et al. (1997), other negative aspects of block scheduling include too much independent study, limited number of electives, overemphasis on lecture, and teacher fatigue toward the middle of the second semester.

Research Questions

Because of the equivocation in the research literature on achievement effects of block scheduling *a priori* research hypotheses were not posed. Instead research questions were developed around the major main effects and interactions of the instructional format variable (4 x 4, AB, and traditional schedules) attribute variables (gender and achievement level) and outcome variables (science process, science content, and language arts).

- What is the effect on science content, science process, and language arts achievement of learning that content in 4 x 4 block scheduling, AB block scheduling, or traditional scheduling?
- How do those effects vary depending on student gender and prior student achievement levels?

Although these research questions are posed across all outcome and independent variables, the language arts study and the science studies were sufficiently different in sampling designs and analyses to merit separate methodological and results sections.

Language Arts Study

Method

Population, Sample, and Sampling Design

The theoretical population for this *ex post facto* study is students who attend either junior high school or middle school in moderately sized cities in the mountain west. The actual sample for this study was 111 students who attended two different junior high schools in a city of approximately 125,000 in Colorado. In an attempt to overcome some of the weaknesses in causal inferences associated with *ex post facto* designs, a two-stage sampling design was used and is described below.

School selection stage of the sampling design. Block Schedule School (BSS) was the school of interest in this study primarily because the school had implemented both 4 x 4 block scheduling and AB block scheduling simultaneously for several years, representing a relatively unique opportunity to examine differential effects of both forms of block scheduling while controlling for school effects. Additionally, the same language arts teacher taught in both the 4 x 4 and AB block scheduling modalities, and taught the same curriculum across both modalities, adding important internal controls for both curriculum and instruction across both conditions. Finally, this teacher taught both 4 x 4 and AB block scheduling modalities in the same academic years of this study (i.e. 4 x 4 classes in the morning; AB classes in the afternoon) thus helping to control for differential historical threats across these two conditions.

To generate a comparison sample of students from a traditionally-scheduled school, a comparable school—Traditional Schedule School (TSS) was selected. Although TSS was considerably smaller in total number of students (450 students versus 750 for BSS), the similarities of these two schools on other important features were quite close. Both had a relatively mature teaching force; both were located on the same sector of the city, that is very heterogeneous in the types of families that live there; and both had very similar 2001 reading (72% - BSS versus 69% - TSS); writing (48% versus 41% respectively); and mathematics (51% versus 52% respectively) proficiency ratings on the state's high stakes examinations. TSS also averaged approximately 4 students less across all grade levels in student/teacher ratio than BSS.

Student selection stage of the sampling design. The sample of students from BSS in the 4 x 4 block scheduling and AB block scheduling groups were those students in the 1998-1999 and 1999-2000 academic years who were taught their language arts courses by the instructor associated with this study. These students numbered 131 students in 4 x 4 block scheduling and 134 in AB scheduling groups. From these initial numbers, data were collected from the school district database on these students' 6th grade language arts Iowa Test of Basic Skills (ITBS) test scores, converted into Normal Curve Equivalents (NCE's). Due to missing data on these ITBS scores, these initial sample sizes were reduced to 102 and 95 language arts students in 4 x 4 and AB block scheduling respectively.

A random sample of approximately 60 students from each of the two years was then drawn from TSS and 6th grade language arts ITBS test scores, converted into NCE's were collected on each of these students. Again, missing ITBS test

score data reduced these TSS samples down to 97 students. A Pearson correlation was then conducted for these 294 correlating these ITBS scores with the outcome variable of interest – the students' 9th grade language arts RIT score (described below). The correlation was .75, which suggested the 6th grade ITBS score was an excellent matching variable on which to equate individual students.

The final student sampling process then, involved matching individual students in each of the three instructional format groups by gender and by 6th grade ITBS scores. To do this matching process the students were sorted by group, and then by gender and ITBS scores in language arts. The process was then followed wherein, for example, a male student who was in the 4 x 4 block scheduling group and who might have had a language arts 6th grade ITBS score of 33.2 was matched with a male from each of the other two instructional groups who also had a language arts ITBS score of 33.2. This matching process was followed producing a 100% match on gender, and a better than 90% exact match on ITBS scores. In those cases where there was not a perfect 3-group match on ITBS scores, at least two of the three scores were an identical match, and the off-matched score was never more that +/- 2 NCE's. In order to maintain this high level of matching, however, a significant attrition occurred in each database. The final language arts sample ended up having 37 complete cases with the dataset organized for a mixed ANOVA analysis.

Interventions

Students in the BSS science and language arts classes were enrolled in either a 4 x 4 block format or an AB block format. Students in the AB block format met every other day throughout the entire school year. Students in the 4 x 4 block format met every day of the week for a single semester. Those students in the 4 x 4 block format who enrolled in the fall semester took the outcome achievement tests in language arts and science (see description below) in the first week of December. Students in the 4 x 4 block format who enrolled in the spring semester and all students in the AB block format took the outcome tests in second week of April. The curriculum, instructional formats, laboratory activities, projects, and other in-class activities were identical for students in both block formats and within each of the science and language arts curricula. Students in the TSS received instruction in science and language arts for the entire academic year in 50 minute classes every day of the week.

Variables

The dependent variable for this study was the students' 9th grade language arts RIT score on the criterion-referenced levels test which was administered in the late fall and late spring of each year of this study. The levels test (Northwest Evaluation Association, 1997) is a well-established achievement test battery that allows school districts to measure growth in student learning from one year to the next

The within subjects variable was the instructional format used to teach language arts – with three levels – 4 x 4 block scheduling, AB block scheduling, and

traditional scheduling. The between groups variables for this study were the students' gender, and the students achievement levels in language arts as they entered junior high school. To create this achievement level variable, the students' 6th grade ITBS scores were sorted above and below the median level of this ITBS score creating a two-level variable.

Analysis

The data for this study were analyzed using a 3 x 2 x 2 mixed ANOVA with repeated measures on the first factor (instructional format). Gliner & Morgan (2000) asserted that the appropriate analytic technique for matched student sampling designs is to treat the grouping variable as a within subjects variable and use repeated measures analyses as the statistic. A total of 37 complete cases were used in this analysis.

Results

Table 1 presents descriptive information about the samples of students who were included in the language arts analysis. Levene's test for equality of variances proved non-significant for all three instructional formats and Mauchly's test for sphericity also proved non-significant ($X^2 = 0.129$, $df = 2$, $p. = .938$).

Table 2 presents the ANOVA source table for this language arts analysis. As can be seen, achievement in language arts at the 9th grade level varied significantly across instructional format, $F\ (2, 66) = 4.89$, $p = .01$. The strongly significant differences on the main effect of achievement level suggest appropriate separation between the two achievement level groups; similarly, the negligible main effect on gender suggests relative equality of these two groups. Statistically significant effects were also found on the interaction between instructional format and gender, $F\ (2, 66) = 3.16$, $p < .05$, and between instructional format and achievement level $F\ (2, 66) = 8.06$, $p < .01$. Post hoc analyses using a Tukey HSD are presented in Table 3 for all statistically significant pairwise comparisons (excluding gender and achievement level main

Table 1. Means and Standard Deviations for 9th Grade Language Arts Achievement Broken out by Instructional Format, Gender, and Achievement Level

	Males			Females		
Instructional Format	**M**	**n**	**SD**	**M**	**n**	**SD**
	Low Achieving Group					
4 x 4 Block Scheduling	222.50	8	4.44	218.50	8	8.18
AB Block Scheduling	225.38	8	4.14	226.50	8	7.09
Traditional Scheduling	212.00	8	7.87	220.13	8	7.49
	High Achieving Group					
4 x 4 Block Scheduling	230.78	9	7.31	227.42	12	5.76

AB Block Scheduling	230.00	9	7.26	230.83	12	7.71
Traditional Scheduling	232.56	9	7.33	231.17	12	5.69

effects, and the instructional format by gender interaction – see Figure 1 and corresponding narrative for explanation) along with effect sizes.

As can be seen in Table 3 and Figure 1, AB block scheduling generated a small to moderate main effect over traditional scheduling (Cohen, 1988); 4 x 4 block scheduling did not. Much more interesting and powerful, however, were the effects that both forms of block scheduling seemed to hold for those students who entered junior high school in the bottom half

Table 2. Analysis of Variance for 9th Grade Language Arts Achievement as a Function of Instructional Format, Achievement Level, and Gender

Source	df	SS	MS	F	p
Instructional Format	2	385.60	179.30	4.89	.01
Achievement Level	1	2501.30	2501.30	38.58	.00
Gender	1	1.33	1.33	0.02	.89
Instructional Format x Gender	2	231.31	115.65	3.16	.045
Instructional Format x Achievement Level	2	590.85	295.42	8.06	.001
Achievement Level x Gender	1	63.02	63.02	0.97	.33
Instructional Format x Achievement Level x Gender	2	141.75	70.87	1.93	.15
Error (Instructional Format	66	2419.22	36.66		

Table 3. Statistically Significant Pairwise Comparisons and Effect Sizes for the Language Arts Analyses

Pairwise Comparisons	M diff	p	d[a]
AB Block Schedule versus Traditional Schedule	3.54	.006	.40
Low Achievers in 4 x 4 Block Schedule versus Low Achievers in Traditional Schedule	3.90	.025	.51
Low Achievers in AB Block Schedule versus Low Achievers in Traditional Schedule	7.09	.000	1.39

[a]calculated using weighted, pooled standard deviation formula

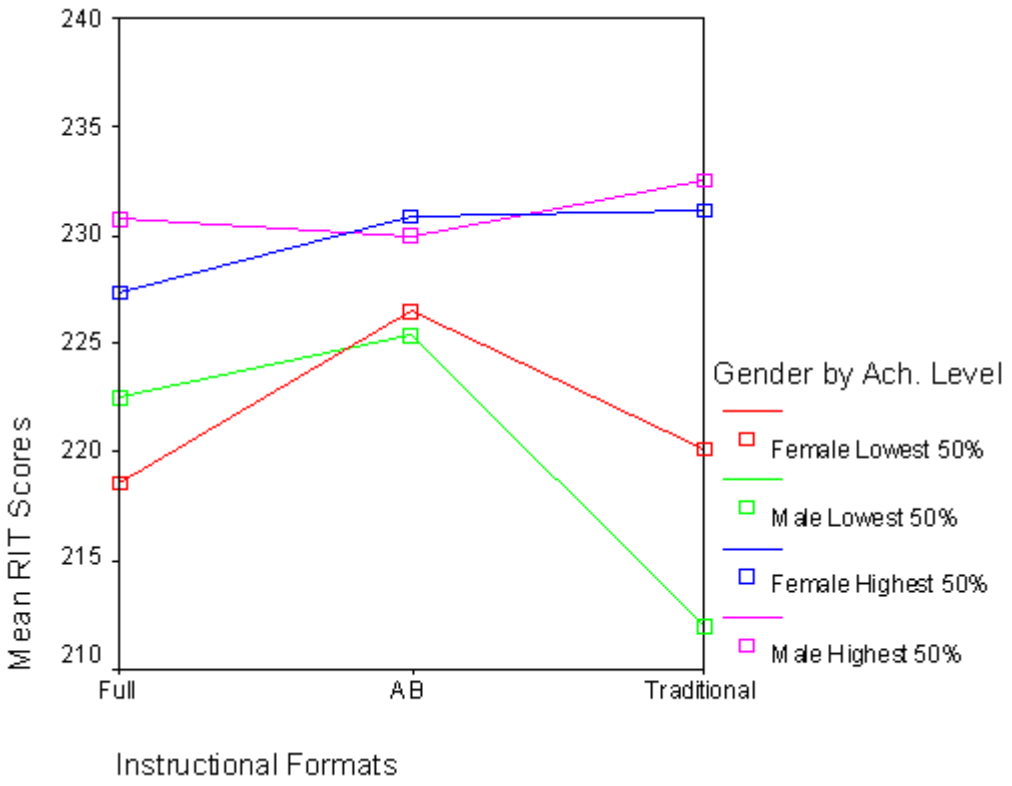

Figure 1. Mean language arts RIT Scores for students in 4 x 4, AB, and traditional schedules broken out by gender and achievement levels.

of language arts achievement distribution. Here, both forms of block scheduling had significant advantages over traditional scheduling, with 4 x 4 block scheduling generating a moderately strong effect size, and AB block scheduling demonstrating a very large effect size – nearly three times that of 4 x 4 block scheduling. Looking at Figure 1, it appears that the significant format by gender interaction was due in large part to the disparity of scores in the traditionally-scheduled school and hence does not appear to be a genuine effect worth reporting.

Science Content and Process Study

Method

Population, Sample, and Sampling Design

The theoretical population for this *ex post facto* study is identical to the language arts study above. The actual sample for both of these science analyses was 340 students. These students were drawn from the same two schools as the language arts study; however, the lack of a well-suited matching variable changed the sampling design and subsequent analyses. Hence the school selection stage of the two stage sampling design described in the language arts study was exactly the same for this science content and process study. For example, the same science teacher taught in both the 4 x 4 and AB block scheduling modalities, and taught the same curriculum across both

modalities and in the same academic years of this study.

Student selection stage of the sampling design. The sample of students from BSS in the 4 x 4 block scheduling and AB block scheduling groups were those students in the 1998-1999 and 1999-2000 academic years that were taught their science courses by the instructor associated with this study. These students numbered 114 students in 4 x 4 block scheduling and 102 in AB scheduling groups. Similar to the language arts study, data were collected from the school district database on these students' 6th grade mathematics ITBS test scores, converted into Normal Curve Equivalents (NCE's). Due to missing data on these ITBS scores, these initial sample sizes were reduced to 88 and 83 students in 4 x 4 and AB block scheduling respectively.

A random sample of approximately 60 students from each of the two years was then drawn from TSS and 6th grade mathematics ITBS test scores, converted into Normal Curve Equivalents (NCE's) were collected on each of these students. Again, missing ITBS test score data reduced these TSS samples down to a total of 97 students across the two years of the study. Then, two Pearson correlations were conducted for these 264 students correlating these ITBS scores with the outcome variables of interest – the students' 9th grade science process and content RIT scores. These correlations were .39 for the science content/ITBS math correlation and .41 for the science process/ITBS math correlation, which, although both statistically significant at the $p < .01$ level, did not correlate well enough to justify their use as a criterion for a matched sampling design. Hence, this study was conducted and analyzed as a factorial between groups design.

Variables

The dependent variables for this sub-study were the students' 9th grade science content and process RIT scores on the criterion-referenced levels test which was administered in the late spring of each year of this study. The three between groups variables for this study were: (a) the grouping variable, with three levels (4 x 4 block scheduling, AB block scheduling, and traditional scheduling); (b) students' gender; and (c) the students achievement levels in 6th grade mathematics as they entered junior high school, blocked into two groups—those at the median and above, and those below the median.

Analyses

A preliminary one-way ANOVA was conducted using the mathematics ITBS NCE scores as the dependent variable and the instructional formats as the grouping variable. This analysis tested the viability of the assumption that the matching process using math ITBS scores served to equate, in some measure, the students in the three groups. This ANOVA proved non-significant $F(2, 267) = .149$, $p = .862$, lending some credibility to the assumption of equality of groups.

The outcome data for this sub-study were analyzed using two 3 x 2 x 2 between groups ANOVA's. The decision was made not to use a single MANOVA due to the high correlation (r = .70) between the two dependent variables (science

process and science content). Cole, Maxwell, Arvey, & Salas (1994) recently recommended using separate univariate ANOVA's when the expected effect sizes for both analyses are reasonably large and consistently in the same direction, and when there is a high correlation between the two dependent variables.

Science content. Table 4 presents descriptive information about the science content sample. Levene's statistic, testing the assumption of equality of variances across the various

Table 4. Means and Standard Deviations for 9th Grade Science Content Achievement Broken out by Instructional Format, Gender, and Achievement Level

	Males			Females		
Instructional Format	**M**	**n**	**SD**	**M**	**n**	**SD**
	Low Achieving Group					
4 x 4 Block Scheduling	218.74	19	15.11	218.59	22	10.81
AB Block Scheduling	214.76	17	13.95	217.29	21	6.07
Traditional Scheduling	210.83	24	9.30	207.85	20	6.17
	High Achieving Group					
4 x 4 Block Scheduling	223.30	30	11.50	220.94	17	9.59
AB Block Scheduling	221.33	15	8.15	222.00	30	9.62
Traditional Scheduling	222.54	26	8.36	219.68	28	8.41

levels of the three independent variables proved statistically significant, F (11, 257) = 2.04, $p < .03$. Hence, for all post hoc tests the Games-Howell test was used which Field (2000, p. 276) recommended to be used when samples sizes are relatively small and unequal, and the assumption of homogeneity of variance has been violated.

Table 5 presents the ANOVA source table for this science content analysis. As can be seen, achievement in science content at the 9th grade level varied significantly by instructional format, F (2, 257) = 6.40, $p = .002$. Statistically significant effects were also found on the interaction between instructional format and achievement level, F (2, 257) = 4.22, $p < .016$. Of course, the statistically significant main effect for achievement level was not of interest in this

Table 5. Analysis of Variance for 9th Grade Science Content Achievement as a Function of Instructional Format, Achievement Level, and Gender

Source	df	SS	MS	F	p
Instructional Format	2	1279.65	639.82	6.40	.002
Achievement Level	1	3095.66	3095.66	30.96	.000
Gender	1	47.34	47.34	0.47	.49

Instructional Format x Gender	2	220.73	110.37	1.10	.33
Instructional Format x Achievement Level	2	844.69	422.35	4.22	.016
Achievement Level x Gender	1	27.65	27.65	0.28	.60
Instructional Format x Achievement Level x Gender	2	18.01	9.01	0.09	.91
Error (Instructional Format)	257	25693.37	99.99		

analysis; no significant main or interaction effects were found on the gender variable. Post hoc analyses using the Games-Howell statistic along with effect size estimates are presented in Table 6 for all statistically significant pairwise comparisons; Figure 2 graphically displays these comparisons.

Table 6. Statistically Significant Pairwise Comparisons and Effect Sizes for Science Content Analyses

Pairwise Comparisons	**M** diff	**p**	**d**[a]
4 x 4 Block Schedule versus Traditional Schedule	4.82	.009	.44
Low Achievers in 4 x 4 Block Schedule versus Low Achievers in Traditional Schedule	9.18	.003	.89
Low Achievers in AB Block Schedule versus Low Achievers in Traditional Schedule	6.68	.022	1.01

[a]calculated using weighted, pooled standard deviation formula

As can be seen in Table 6 and Figure 2, 4 x 4 block scheduling generated a moderately strong main effect over traditional scheduling; AB block scheduling did not. This finding is a reversal of the block scheduling main effect found in the language arts analysis above, but still suggests an advantage for block scheduling formats over traditional scheduling. As with the language arts analysis, the more interesting and powerful effects were found in favor of both forms of block scheduling for those students who entered junior high school in the bottom half of mathematics achievement distribution. Here, both forms of block scheduling had significant advantages over traditional scheduling, with both forms of scheduling demonstrating large effect sizes over traditional scheduling. Figure 2 displays this pattern of findings. Of equal interest,

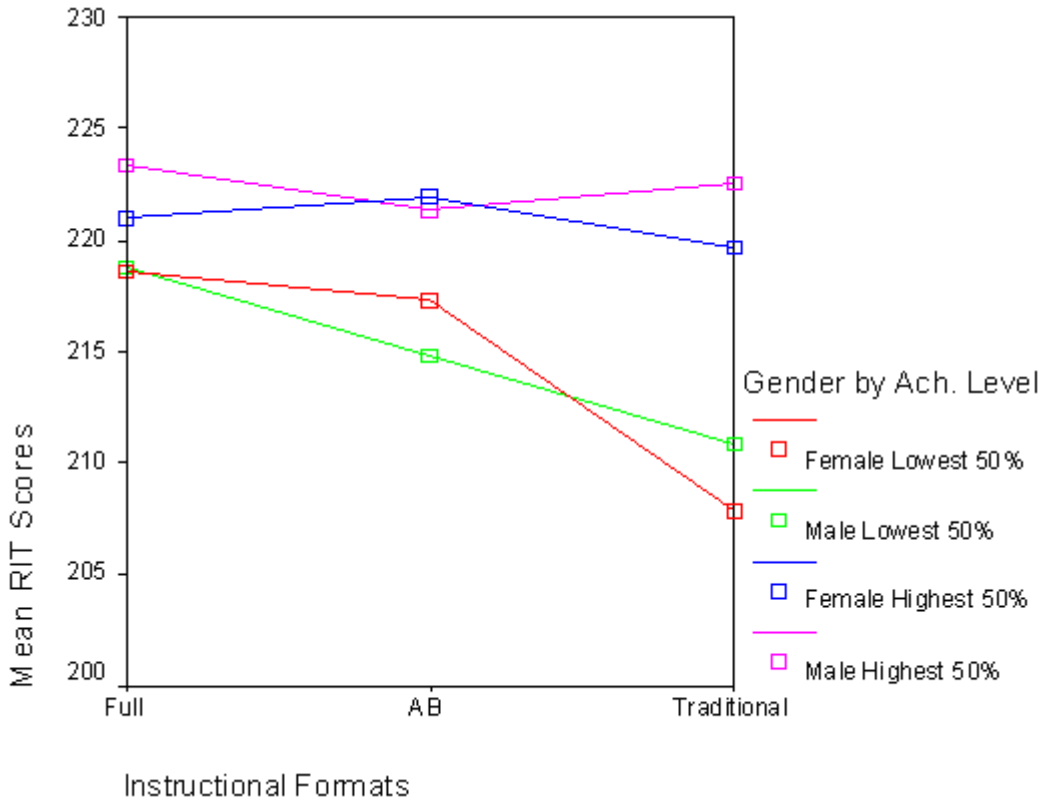

Figure 2. Mean science content RIT scores for students in 4 x 4, AB, and traditional schedules broken out by gender and achievement levels.

although not reported below in Table 6 is that *the only subgroup that the high achievers in traditional scheduling format outperformed with statistically significant differences was the traditionally scheduled low achievers.* Thus it appears that block scheduling may be capable of

bringing low achieving students to the levels of their high achieving counterparts who receive science instruction in traditional scheduling formats.

Science process. Table 7 presents descriptive information about the science process sample. Levene's statistic, testing the assumption of equality of variances across the various levels of the three independent variables proved statistically significant, F (11, 255) = 2.68, $p < .003$. Again, then, all post hoc tests used the Games-Howell statistic.

Table 7. Means and Standard Deviations for 9th Grade Science Process Achievement Broken out by Instructional Format, Gender, and Achievement Level

	Males			Females		
Instructional Format	**M**	**n**	**SD**	**M**	**n**	**SD**
	Low Achieving Group					
4 x 4 Block Scheduling	220.63	19	9.62	222.09	22	12.56
AB Block Scheduling	213.35	17	17.69	219.86	21	10.86

Traditional Scheduling	210.54	24	11.75	206.15	20	7.80
	High Achieving Group					
4 x 4 Block Scheduling	223.43	>30	13.13	220.00	17	8.78
AB Block Scheduling	220.40	15	7.89	224.77	31	10.55
Traditional Scheduling	223.35	26	7.58	222.82	28	7.41

Table 8 presents the ANOVA source table for the science process analysis. As can be seen, achievement in science process at the 9th grade level varied significantly by instructional format, F (2, 258) = 6.77, p = .001. Statistically significant effects were also found on the interaction between instructional format and gender, F (2, 258) = 3.10, p = .047, and on the interaction between instructional format and achievement level, F (2, 258) = 10.08, p < .000. Again, the statistically significant main effect for achievement level was not of interest in this

Table 8. Analysis of Variance for 9th Grade Science Process Achievement as a Function of Instructional Format, Achievement Level, and Gender

Source	df	SS	MS	F	p
Instructional Format	2	1598.50	799.25	6.77	.001
Achievement Level	1	3164.46	3164.46	26.79	.000
Gender	1	28.33	28.33	0.24	.63
Instructional Format x Gender	2	732.08	366.04	3.10	.047
Instructional Format x Achievement Level	2	2381.28	1190.64	10.08	.000
Achievement Level x Gender	1	17.74	17.74	0.15	.70
Instructional Format x Achievement Level x Gender	2	227.99	113.99	0.97	.38
Error (Instructional Format)	258	30477.58	118.13		

analysis. Post hoc analyses using the Games-Howell statistic along with effect size estimates are presented in Table 9 for all statistically significant pairwise comparisons; Figure 3 graphically displays these comparisons.

As can be seen in Table 9 and Figure 3, 4 x 4 block scheduling generated a moderately strong main effect over traditional scheduling, almost identical to the effect seen in the science content analysis in Table 6. As with the science content analysis, AB block scheduling did not produce a statistically significant advantage over traditional scheduling. As with the science content effect size analysis, the interactions between instructional format and entering

Table 9. Statistically Significant Pairwise Comparisons and Effect Sizes for Science Content Analyses

Pairwise Comparisons	Mdiff	p	d[a]
4 x 4 Block Schedule versus Traditional Schedule	5.28	.006	.46
Low Achievers in AB Block Schedule versus Low Achievers in Traditional Schedule	12.87	.000	1.20

Females in AB Block Schedule versus Females in Traditional Schedule	8.40	.044	.69
Low Achievers in 4 x 4 Block Schedule versus Low Achievers in Traditional Schedule	7.56	.015	.69

[a]calculated using weighted, pooled standard deviation formula

achievement level strongly favored both block scheduling formats over traditional scheduling although the relative strength of the particular block format was reversed in this analysis. The gender x instructional format interaction was the first time a gender effect appeared in any of these analyses. Looking at the graphs in Figures 1 and 2 compared with Figure 3, this effect would seem to be related to the relatively wide dispersion of mean scores by gender for the AB format in Figure 3 compared with this dispersion in Figures 1 and 2. Given the lack of consistency in this gender x instructional format interaction, however, it is questionable how much confidence can be placed in the veracity of this interaction. Again, as with the science content analysis, the only subgroup that the high achievers in traditional scheduling format outperformed with statistically significant differences was the traditionally scheduled low achievers.

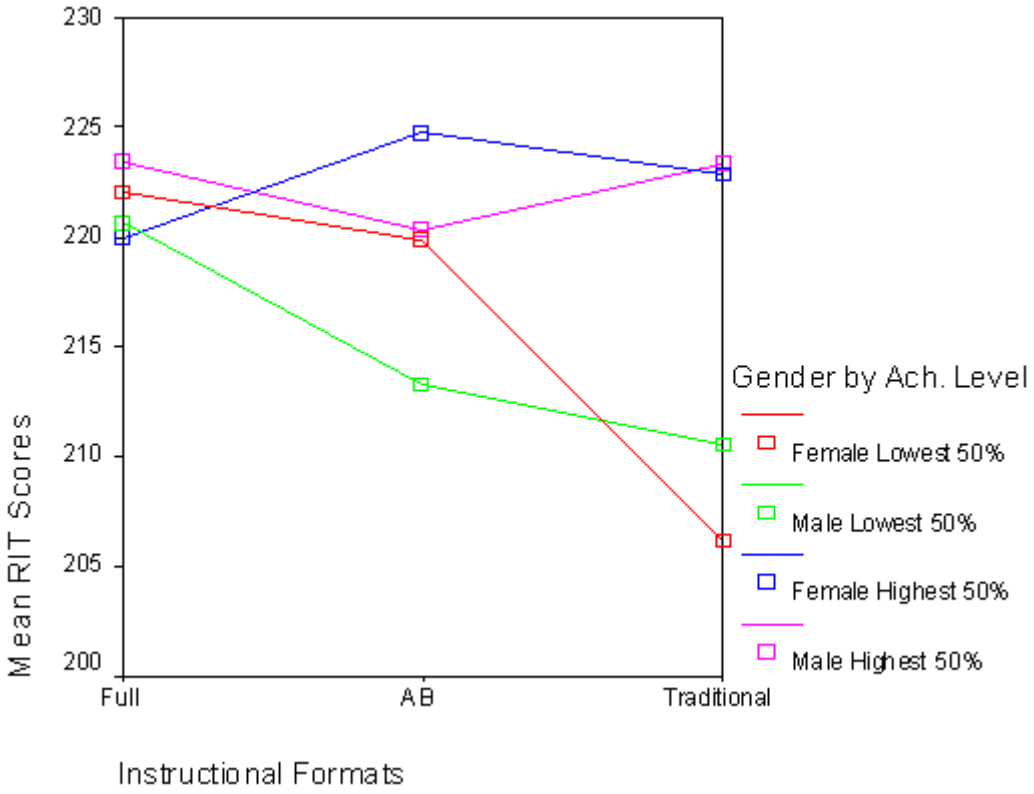

Figure 3. Mean science process RIT scores for students in 4 x 4, AB, and traditional schedules broken out by gender and achievement levels.

Discussion

What is to be made of these findings, especially given Veal and Schreiber's (1999) recent statement "The literature is consistent on the inconsistency of

achievement of students within the block schedule (p. 3)" in their review of literature? It probably makes the most sense to start by considering the non-achievement literature on block scheduling as well. Here, the findings are much more consistent (although not uniformly so), and they to tend favor both forms of block scheduling over traditional scheduling on such things a school climate (i.e. Bickel, 1999), student satisfaction with school (Lapkin et. al, 1997; Knight, De Leon, & Smith, 1999)—except students in AP classes (Knight et al, 1999), and teacher, parent, and counselor satisfaction with school (Edwards, 1999; Wilson & Stokes, 1999; Deuel, 1999). Hence, if the main and interaction effects of block scheduling on student achievement can be "held harmless" versus traditional scheduling then the relatively consistent results on these kinds of "softer" measures above might tip the scales in favor of block scheduling.

Thus, if the "standard" for consistent findings on student achievement of block scheduling is that it *does not produce worse outcomes* rather than that it *does produce positive outcomes*, then the consistency picture does clear up somewhat. Here, Veal and Schreiber (1999) and their follow up study (Schreiber, Veal, Flinders, & Churchill, 2001) found no adverse effects on mathematics, reading, and language arts of attending block scheduled high school classes. Their findings, then, are in conflict with this study on language arts, but at least are consistent on a "no adverse effect" criterion. These researchers also looked only at 4 x 4 and traditional scheduling (and a 4 x 4/traditional hybrid) and did not look at effects of AB block scheduling. Bickel (1999) found no differences between block scheduling and traditional scheduling on mathematics achievement. Wallinger (1998) found no differences on foreign language achievement although Lapkin et al, (1997) found differences in favor of block scheduling on foreign language achievement. Finally, Edwards (1999) found very cautious positive effects of block scheduling on science achievement.

Thus it would seem that the sum of this prior research (our own prior research notwithstanding – see Cobb, Abate, & Baker, 1999) and the findings of this current study would tend to support the use of block scheduling. However, there are a number of limitations both with this current study and with the empirical literature set in general that make this judgment one to be viewed with caution. First, most of the studies cited that looked at student achievement were at best causal-comparative in design, and in some cases, purely correlational. Many of these studies did not even exercise the attempt at controls that this present study did – that is equating schools and students in them. Seldom was there a reporting of the procedures of the block scheduling intervention (except of course, that the length of the class period was longer) and hence there are a whole host of additional variables about the integrity of the block scheduling intervention that are unreported and uncontrolled in these causal-comparative research studies and that bring unmeasured effects into the research results. Also, with multi-school studies, the variable of instructional quality of the teachers independent of the scheduling format, adds a significant unmeasured dimension to the research results.

These limitations notwithstanding, we believe we have findings worth adding to the theoretical mix, and paradoxically, they are characterized by consistency. Looking at the consistency in three graphs and in the magnitude of the

corresponding effect size tables, we consistently found sizeable gains in favor of block scheduling. These gains persevered across both the language arts and science domains of achievement; and these gains were largest consistently in favor of lower achieving students while consistently holding harmless upper achieving students. These are the findings of one junior high school, however, and need to be replicated with high quality quasi-experiments and *ex post facto* studies in order to be generalized to other settings.

In future research efforts we have a number of observations and recommendations that seem particularly germane with the escalating demands for "scientific rigor" in educational research associated with current federal education legislation. First, we recommend qualitative research—particularly case studies, ethnographies, or grounded theory research—that explores several very likely and important sources of variation in prior research results. For example, differing instructional practices by teachers in blocked and traditional scheduled classes are doubtless sources of error variance in achievement results, especially in studies that use only one or a few schools and teachers. Clearly, the context within which block scheduling and traditional scheduling is delivered also has much to do with efficacy of achievement results. Desimone (2002), for example, has recently affirmed in her review of comprehensive school reform model literature Porter, Floden, Freeman, Schmidt, & Schwille's (1988) policy attributes theory about successful implementation of whole school reform. Exploring how schools move to block scheduling by focusing on the attributes of specificity, consistency, authority, stability, and context, case study or grounded theory research can add immense understandings as to how and why achievement results vary as they do across implementation sites.

From the quantitative paradigm, we recommend that university and school-based researchers aim as high as possible within the methodological boundaries they attach to their studies. With group-based studies, we recommend that research begin, if at all possible with schools that are planning a move to block scheduling in order to move the design characteristics from *ex post facto* to quasi-experimentation, with attention to the attendant improvements to controls over threats to internal validity. Documentation of the adoption processes and implementation activities will go a long way to remove and explain sources of error variance that plague *ex post facto* designs and are likely to be the source of the inconsistencies in earlier research.

Nonetheless, we recognize that the preponderance of future quantitative research on block scheduling is likely to be causal-comparative. As such we believe that with careful attention to internal validity features within this design, credible research results can weigh into the discussion about block scheduling such that evidence-based judgments can be made that draw, in part from these kinds of research studies. First, more and more schools are going to hybridized versions of either 4 x 4 or AB block scheduling, and these hybrids must be documented and described. Second, we recommend that outcome measures focus on math, science, and language arts—domains that are likely to be tested more and more with the implementation of *No Child Left Behind* legislation. These are the achievement domains of the first decade of the 21st century and the "social validity" of this research will be enhanced by attention to these

domains. Third, *ex post facto* studies absolutely must measure pre-block scheduled achievement levels of students on measures that are highly correlated with the outcome measures. Whether or not these pre-measures result in matched sampling designs or ANCOVA statistical designs will be more of a judgment call of the researchers, but these pre-measures must be included in the research. Fourth, researchers have to measure the length of time students attended block scheduled and traditional (comparison) schools and eliminate students who were not in those school long enough (i.e. 1-2 years) to demonstrate the effects of those schools' scheduling formats. Finally recommend longitudinal follow up of students, if possible to explore the durability of block scheduling effects (see, for example, the Veal & Schreiber, 1999 and the Schreiber et. al, 2001 studies as an example). We can envision, for example, a methodologically appealing line of research that looked at students in middle/junior high school who were in block scheduled and traditional formats and who then attended, differentially, block scheduled or traditionally scheduled formats in high school.

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