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ABSTRACT

As forms of school restructuring sweep the nation, teachers are interested in how block scheduling will influence their models of professional development. This report examines the effects of a high school's transition from a traditional to a hybrid schedule--three traditional and two block classes each day--on science teaching and learning. Findings indicate that the amount of instructional time influenced the type of teaching strategies employed, and that the specific teaching methodologies used were varied and differed from previous years. (Contains 34 references.) (WRM)

HYBRID SCHEDULING EFFECTS ON SCIENCE TEACHING AND LEARNING

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As forms of school restructuring sweep the nation, teachers are interested in how block scheduling will influence their models of professional practice. This report examines one of the most common trends to restructure secondary schools; block scheduling. Proponents often view block scheduling as a way to extend the traditional periods of uninterrupted class time and improve student achievement. Yet, like other methods of school restructuring, these changes are significant largely in the degree to which they influence the outcomes or day-to-day practice of teaching. As the trend continues to grow throughout the United States, teachers, parents, administrators, and university professors are seeking evidence for the impact of block scheduling on teaching.

Teachers and parents at South Springfield High School (SSHS) studied a proposal to switch the school year from a traditional six period day to a 4x4-block schedule. The change to a 4x4 alternative schedule was proposed after five years of study and consideration. After an experimental six-week block in the fall of 1995, the faculty at SSHS voted in the spring of 1996 to implement the 4x4 for the 1997-1998 school year. Due to pressure from some community members, a tri-schedule was instituted as a compromise for the 1997-1998 school year. A tri-schedule includes three schedules types (traditional, 4x4-block, and hybrid) running at the same time during the school day. It was determined that the tri-schedule would serve during a trial period to determine if the 4x4-block schedule could be implemented. The traditional schedule consists of six 55-minute classes that are taught for the entire year. The 4x4-block schedule

consists of four 87-minute classes each being taught in one semester during which time a year's curriculum is taught. The hybrid schedule consists of three traditional and two block classes each day. Utilizing the unique circumstances present at SSHS (three approaches to scheduling present in one school), this study sought to document the ways that traditional, hybrid, and block schedules differently influenced the possibilities for teaching and learning.[1]

Unlike many university-affiliated research projects, the SSHS administration and teachers initiated this study (Sirotnik, 1988). The school-based initiation of this research was emblematic of the importance of the study to its primary stakeholders (Tanner, 1998). The action research study was important because it informed SSHS as to whether the switch to a block schedule enabled them to achieve important goals (Stringer, 1996; Veal & Tippins, 1996). For example, does the switch to a block schedule alter the teachers' instructional methods; does it change the modes and increase the efficacy of teaching and learning; and does student achievement increase due to block scheduling?

This study fulfilled the important task of being the first to systematically examine and report the effects of the transition from a traditional to a hybrid schedule. The collaborative, two-year study analyzed a relatively comprehensive set of data on the school's first year of implementing a tri-schedule format. The faculty and administration from SSHS initiated this study precisely because they wanted to use its findings to intelligently guide their school practice. They were committed to the idea of block scheduling only to the degree that it, in fact, proved beneficial to their learning community (e.g., Canady & Rettig, 1995; Edwards, 1993). As a result, the hybrid schedule became the focus of the study; specifically, how did the schedule change influence science teaching and learning.

[1] The study was funded by the Research Institute on Teacher Education at Indiana University and by The Spencer Foundation.

Previous Research on Block Scheduling

A few empirical research studies on block scheduling in science do exist (Bateson, 1990; Hess, Wronkovich, & Robinson, 1998; Lockwood, 1995; Raphael, Wahlstrom, & McLean, 1986; The College Board, 1998; Wild, (1998); Wronkovich, Hess, & Robinson, 1997). Even though these studies presented "hard data," the conclusions were tenuous. For example, Bateson (1990) investigated the effects of full-credit semester and all-year timetables on science attitudes and science achievement of grade-10 students. The students were tested on cognitive and affective domain tests. Students in the all-year courses consistently outperformed first- and second-semester students in the cognitive domains. There were no significant differences in the affective domains. Analysis was done using ANOVA statistical techniques. One significant problem with this report was the fact that the content used on the test covered grades eight to ten. Also, no mention was given as to the schedule of the students before their tenth grade year.

The College Board (1998) published an article comparing student achievement on four Advanced Placement (AP) Examinations among schedule types. An analysis of covariance using the PSAT/NMSQT as a covariate was performed. Students who were taught AP biology under an extended traditional class time (meeting everyday for more than 60 minutes) scored higher than students in a traditional schedule and both fall and spring 4x4 schedules. These results might be expected if more time was spent on a daily basis learning any subject. These results reported the effects of the extended traditional schedule and the 4x4, but did not mention other types of block scheduling; such as block 8, trimester or hybrid.

Although there have been some studies that have presented tenuous conclusions, a few have reported usable conclusions. For example, Hess, Wronkovich, & Robinson, (1998) studied the effect of 4x4 block scheduling on student achievement in four areas using "retired" copies of

SAT II Achievement Tests and the Otis-Lennon Scholastic Aptitude Test as a covariate. Regression analysis on pre- and post-tests on biology indicated a significant difference between the block and traditional students' achievement. Students in the intense block class out-performed their traditional counterparts.

Even though researchers have reported the benefits of block scheduling on student achievement, these studies have not mentioned or addressed the type of teaching or the change in teaching methods used in the block classes or schedules. Papers and research that have addressed the issue of teaching in the block schedule format have only reported on the attitudinal effects the schedule has had on the teachers through surveys. In fact most surveys were administered once the teachers had already changed to the block schedule. The subjective nature of survey data and the lack of a direct comparison to teaching under both schedules have led to criticism of these reports.

The majority of research conducted over the past decade has focused on student outcomes as a dependent variable. In particular, studies have examined the relationship between block scheduling and student grade point averages (Buckman, King & Ryan, 1995; Edwards 1993; Schoenstein, 1995), state standardized test scores (North Carolina Department of Public Instruction, 1996), college entrance exams (Hess, Wronkovich & Robinson, 1998) and graduation rates (Carroll, 1995; Munroe, 1989). The findings of these studies have been inconsistent, sometimes reporting gains for students on block scheduling, sometimes reporting no difference, and sometimes reporting losses compared with students on traditional scheduling. For example, Averett (1994) compared mathematics achievement at twenty-one North Carolina schools, and found an increase in scores at the schools that had recently changed to a semester block schedule. However, Marshall et al. (1995) report a study of mathematics achievement

conducted in British Columbia schools that found block students scoring lower than students on a traditional schedule. At one level, these findings are not difficult to explain. In reviewing seven studies of mathematics achievement, including the two cited above, Kramer (1996) concludes: "It is likely that the contrasting results . . . are owing to important differences in the way block scheduling was implemented" (p.766).

This conclusion is an important reminder that the effects of block scheduling on achievement are mediated by its effects on classroom practice. Advocates of block scheduling argue that this strategy increases student achievement by providing an impetus for professional development and opportunities for improved methods of teaching (Canady & Rettig, 1996; Holtenstein, 1998). Yet, effects on practice have been studied less often than effects on achievement. At best, researchers have only begun to tentatively identify the types of changes in practice that may be associated with block scheduling. These possible changes include greater variety in the use of teaching methods (Canady & Rettig, 1996), more frequent use of individualized instruction (Eineder & Bishop, 1997) and small-group activities (Boarman & Kirkpatrick, 1995), together with adjustments in content coverage (Kramer, 1997). The National Science Teachers Association (NSTA) published a compendium of articles on teaching science in the block schedule. Moreover, none of these articles mentioned data to support the practices suggested by the authors.

Purpose

The relationships among science teaching practice and student achievement are notably complex because they involve a constellation of factors beyond block scheduling per se. For this reason, this study draws on a somewhat broader body of scholarship that examines change within the context of classroom science teaching. Eisner (1990) and others (e.g., Cuban, 1993) point to

the stability of this context, arguing that: 1) large class size usually favors conventional forms of whole-group instruction, 2) school and state-wide testing practices mitigate against curriculum changes, 3) textbooks tend to standardize course content, and 4) self-contained classrooms often isolated teachers from school reform.

While this study examined the effects of block scheduling on teacher practice and student achievement, it also sought to recognize the professional lives of teachers as a context for both change and stability. The research question, therefore, is twofold: How does block scheduling change science classroom practice within specific subjects, and how does block scheduling effect student science achievement?

Methodology

The research methodology used in this study included quantitative and qualitative strategies. The multiple strategies provided a basis for validating and contextualizing the research (Miles & Huberman, 1984). This type of approach was employed because previous studies were limited in their analyses and focus (e.g., Guskey & Kifer, 1995; Hackman, 1995). Previous studies only included percentages, descriptive statistics, and listings of comments in their reports (e.g., Angola High School, 1997). The current data were generated from two teacher surveys, a parent survey, a student survey, the student records computer database, and semester exam item analyses.

Context

South Springfield High School is a large, four-year school located in a medium-sized college town in the Midwest. The student population of 1800 is mostly white, combining children from the city and rural areas of the county. In the fall of 1997, SSHS began the scheduling format described earlier. Under this format, both traditional and block courses are offered in all subject

areas except the performing arts and advanced placement classes. The total contact time in block courses is approximately 37 hours less than for yearlong traditional courses (Table 1). This equates to 40 fewer class meetings for block classes than traditional classes. Initially, students were randomly assigned either a traditional or block schedule. Due to parental requests, class scheduling, and class sizes, some students were placed in a hybrid schedule. Teachers were asked to choose either a traditional, block, or hybrid schedule to accommodate the course selections of the students.

Table 1
Descriptive information for classes under block and traditional schedules.

Schedule Descriptors	Traditional	Hybrid	4X4 Block
Class Time (mins./day)	55	55 and 87	87
Number of Days of Instruction	180	180 and 90	90
Class Time (mins./school year)	9900	9900 and 7830	7830
Classes/Day	6	5	4
Classes/Year	6	7	8
Hours/Day	6.5	6.5	6.5
Credits	12	14	16
Teacher Utilization Rate[a,b]	83%	83%[b]	75%
Teacher Preparation (mins.)[c]	55	55	55

a. Defined as the total teaching contact hours divided by the total class time during a day.
b. Teacher utilization rate was the same for all teachers due to contract and union regulations.
c. Teachers in the hybrid and block classes had additional duty time" to compensate for the extra time during the preparation period.

Instruments

Surveys

Four surveys (two teacher, one parent, and one student) were administered, and measured the level of agreement (Likert scale ranging from –2 = strongly disagree to 2 = strongly agree) of the respondent to a series of statements concerning the new scheduling scenario. The first teacher survey was administered to all teachers just before the semester break in January and then again half way through the second semester. This was done to monitor for changes in attitudes over time. Two additional questions on the teacher survey focused on the loss of instructional time in

the block classes and the possible addition of course offerings as a result of block scheduling. The parent survey was mailed in January and returned by postage paid mail during the following three months. The student survey was administered at the end of the school year. Even though the surveys were administered to all teachers, parents, and students, general results were ascertained as guidelines for further inquiry in the area of science. Survey data results are given for all stakeholders, but the focus of the paper is on just the science teachers and subjects. Statistically relevant results could not be ascertained only for science due to the small number of science teachers. Comments and general themes from the larger teacher population were used to guide the results and discussion of the science teachers.

Semester Exams

An item analysis of exam questions within subject areas was one aspect of the project initiated by the faculty and administration at SSHS. The science department at SSHS came together to determine curriculum goals for each subject area. The teachers in each subject area created common questions that assessed the content covered during each semester for each course in block and traditional classes based upon those curriculum goals. Subject teachers had the flexibility to create types and quantity of questions for each semester exam. The majority of the questions developed for the semester exams were multiple choice due to the time frame for evaluation. Exams given by teachers had only some common questions from which comparison could be made. Each teacher for their own classes selected the rest of the questions on the exam.

Comparable pairs of traditional and block classes were identified before analyzing the data with the t-test. The measure of comparability was the average 1996-1997 grade point average (GPA) of all students enrolled in each fall semester class. To determine comparability, the difference between last-year GPA for traditional and last-year GPA for block for each course

was derived. This difference was then divided by the lower last-year GPA value. If the quotient was within 5 percent, the classes were considered comparable.

There were some limitations to the data analyses of semester exams. First, all questions were multiple choice. Second, although some questions were generated mutually by block and traditional teachers, block teachers due to the early occurrence of their exams chose questions based upon completed content and not on anticipated content completion by which traditional teachers made their decisions.

Data Analysis

Teachers, parents, and students answered questions on surveys based upon a five point Likert scale, and provided additional comments as appropriate. One-way ANOVA analyses were performed on the Likert responses, and qualitative data analysis was completed on the written responses. One-way ANOVA tests were also performed on data retrieved from the student databases. Teachers also compiled item analyses from semester tests in each major subject area in science. The research methodology used in this study included quantitative and qualitative strategies. We employed this type of approach because previous studies were limited in their analyses and focus (e.g., Guskey & Kifer, 1995; Hackman, 1995). Our study systematically examined the qualitative and quantitative aspects of block scheduling. The quantitative data were obtained from 70 teachers who voluntarily completed a 10-question survey. The teachers answered each question on a five point Likert scale and provided additional comments as appropriate (See Appendix A). Certain groupings of data produced very small sub-sample sizes, (e.g., grouping by subject area produced a sample size of two for music teachers and four for business teachers). Thus, these small sub-samples need to be considered as we interpret the data. Teachers also compiled item analyses from semester tests in each major subject area.The

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Results

Surveys

All four surveys were administered to all teachers, parents, and students. The response rates were 91 percent and 88 percent for the two teacher surveys, 19 percent for the parent survey, and 64 percent for the student survey. The results are not specific for science. The significance of various questions provided themes to guide classroom observations, interviews, and qualitative analyses. Qualitative responses on the surveys did provide discipline and content specific data for analysis. Table 2 shows some themes from questions on the three surveys. The numbers in the table represent F values and their corresponding levels of significance with two degrees of freedom. The alpha level was set at a 95 percent confidence.

Instructional Methods

According to responses from surveys, interviews, and observational data, instructional methods for most of the teachers with block classes changed. Two general themes emerged from

the data. First, the amount of time influenced the type of teaching strategy employed. Second, the specific teaching methodologies used were varied and differed from previous years.

The time in block classes was longer during each period, but for the duration of the year, block classes had 22 percent less time to cover the same amount of content. Both aspects of time effected learning and teaching. Students, parents, and teachers were split on the effectiveness of science teaching and learning in the block schedule. The negative responses focused on the pace

Table 2
Common themes and one-way ANOVA with Tukey post hoc significance among teacher, parent, and student surveys.

Survey Question	Teacher Survey 1[a]	Teacher Survey 2	Parent Survey	Student Survey
Teachers' instructional methods have changed.	**8.065** **.001**	**7.165** **.002**		**29.148** **.000**
	TB, TH[b]	TB, TH		TB, TH
Anxiety level has decreased.	0.838 .437	**3.159** **.050**	**5.985** **.003**	**3.317** **.037**
		TH	TB, BH	TB
Grades have improved.			**5.268** **.006**	**17.996** **.000**
			TB	TB, BH
Assessment has changed.	**5.630** **.006**	0.794 .457		**10.079** **.000**
	TB, BH			TB, TH
Relationship between teacher and student has not changed.	**5.676** **.009**	**3.462** **.038**		**22.658** **.000**
	TB,TH	TH		TB, BH

a. Numbers reported are the F and p values at a 95% alpha level.
b. TB represents significance between the traditional and block schedules.
TH represents significance between the traditional and hybrid schedules.
BH represents significance between the block and hybrid schedules.

of instruction and content coverage. For example, a junior student on the hybrid schedule commented, "Teachers seem to be rushed to get the material covered that is 'suppose' to be covered. It is hard to keep up sometimes especially in math or science." Parents were also cognizant of the impact the loss of instructional time had on teaching and learning. "Biology in

block format was awful. The teacher stressed to complete the chapters. I felt my daughter was not comprehending the material." One parent aptly stated that "one [teacher] would have to give up (in block) either content or thoroughness." Teachers agreed with the students and parents on both negative aspects of time. "Much more has to be covered in what seems like fewer hours – but the students are still 14 & 15 years old and the concepts are just as difficult." The main reason for the negative aspects of block teaching in science was due to the loss of instructional time overall, and not on the length of time for a class each day.

On the other hand, the positive aspects of time while teaching on the block schedule focused on diversity, reflection, and content coverage. One student on the block schedule mentioned "We've been able to do more things in a class period like take a test and do a lab in one period." Most of the parents responded in a similar manner. In particular, the parents who responded positively to the block schedule for a specific course being in the block format supported the longer block class time for science. "Block is ideal for science with necessary labs and projects that need the longer time frame." Half the teachers agreed with the positive aspects of time in the block schedule for science teaching and learning. One teacher commented on the decreased amount of time as an impetus for restructuring or thinking about the curriculum. "It has required me to analyze the curriculum in terms of the specific lessons and activities I do, and decide what is mot important in order to meet our objectives." A hybrid teacher who had previously taught in a hybrid type schedule commented that "blocking does change teaching – 2-day labs can be done in one." Most of the science teachers believed that labs were taught and understood better in block classes as long as teaching methods changed with the amount of time. In terms of content coverage, one science teacher did mention in the second survey that "less material was covered, more depth (completion)." More specifically, teachers in physics viewed the shortened block

classes as problematic for content coverage (interview, 3/6/98). Biology teachers also felt the pinch for content coverage, whereas the chemistry teachers had few problems covering the content. One hybrid chemistry teacher stated, "I actually covered more material in my block classes than in my traditional classes, because of my increased focus and different teaching methods" (interview, 4/2/98).

In term of instructional strategies, students noticed group work and lab work as most predominant teaching methods used by teachers. A senior in the block schedule commented on her teacher's use of group work and it's specificity to science; "It depends on what subject. Chemistry, yes." Teachers' responses were mostly general. For example, a hybrid science teacher stated, "Block classes have more variety during a class period." Another hybrid teacher commented, "Less notes/ more students doing more thinking (higher level) [actual quotation marks of teacher]." Some responses did focus on specific teaching methods or changes. For example, one science teacher stated, "I go to more discussion and less lecture." A hybrid teacher stated that she/he tried "to do more in-class activities and less note-taking and lecturing." Block classes did effect the types of instructional activities and methods used by science teachers.

Anxiety Level

In the first survey, teachers indicated increased levels of anxiety across all three schedule types. In the second survey, hybrid teachers indicated increased levels of anxiety significantly more often than traditional or block teachers. Hybrid teachers (as well as traditional and block teachers) most frequently attributed anxiety to change in general. "I had both block and traditional, in block finding a combination of activities that work is stressful." Another hybrid teacher wrote, "Much higher stress level!" One hybrid science teacher mentioned that the increased number of preparations on the hybrid schedule was what caused greater stress. "there

is a big difference between having 2 and 3 preps on a block or hybrid schedule." Increased anxiety among teachers was in relation to the increased number of students per class, more preparations, and increased content presentation regardless of the schedule format.

Teachers who were more specific in their written responses reported that their increased anxiety was a function of having more students in each class and increased pace of instruction. A traditional teacher wrote, "More students and extra grading period equals high anxiety." In addition to teachers' concerns, parents also worried about the effect the pace of instruction had on content coverage. Even though some parents favored moving to block because certain concepts "fit the longer classes better," they also complained about which "content items were eliminated." Parents and teachers felt the combination of increased pace of instruction and decisions about what content to eliminate increased the anxiety levels of students and teachers.

Students' Grades

Students and parents felt that the students' grades increased in block classes as compared to comparable traditional classes. The significant difference was between parents of traditional and block students. Block students also significantly felt their grades improved more so than traditional or hybrid students. This assertion was supported with interview responses from parents and students. Many factors were attributed to this general feeling. For example, students could focus on fewer classes in block or hybrid schedule. Second, students could see the "light at the end of the tunnel" in the shorter semester classes. Third, "daily and intense contact with a subject matter" (chemistry teacher interview) was one reason for the grade increase in block classes.

Assessment

Assessment was another area of change for some science teachers due to the block classes. Few of the answers were specific, and their comments ranged from "not really" to "I still use tests." For example, a block teacher mentioned that she/he used "similar methods in blocked and traditional classes." For one hybrid teacher, the mixture of classes provided an opportunity to alter his assessment practices. "Less tests/ more comprehensive assessment and checking if the students understand connections of the material." The same teacher in the second survey also stated that he accomplished "quality goals." Some teachers did broaden their conceptualization of assessment to include the development of alternate means of grading. A biology teacher stated, "Recently we just did rubrics in both of the classes about the same time which was kind of hard. One of the projects was for the DNA model, making DNA models and then the other one was on habitat and niche."

Relationships with Students

In the first teacher survey, the question of whether relationships with students had changed due to schedule type elicited responses across all three groups. In the second survey, most teachers gave largely neutral or positive responses. The statistically significant difference using ANOVA statistical test was determined between block and traditional teachers, and also between hybrid and traditional teachers (see Table 2). Statistical significance was also determined using Pearson chi-square test between schedule types. Significance using chi-square analysis was found only in the second teachers' survey ($X^2 = 11.539$, $df = 2$, $p = 0.021$). Among the hybrid teachers who reported change, both positive and negative effects were mentioned in their written comments.

Positive changes were attributed to increased daily contact as well as to seeing fewer students per day. A hybrid teacher attributed the difference to extended class periods, reporting that, "In

87 minutes, I have greater opportunity to interact with students, and that helps in learning how to deal with individual problems." Another hybrid teacher stated, "I see less students in one day and stronger relationships have formed." A traditional teacher mentioned, "I have 5-7 more students per class period. I feel this affects my interactions with students." Personal relationship with students was an indirect benefit of block scheduling. The block or hybrid schedule only positively effected the relationship if it caused the number of students in a class or in a day to decrease.

Science Teacher Data

Course GPA data were collected from four hybrid science teachers. Table 3 shows the teacher, course, and GPA for general biology, chemistry, and physics. In all cases the teacher did modify his/her instructional methods due to the class type – block or traditional. It was determined that this comparison was better than a list of all traditional verse all block classes due to the direct comparisons made within classes.

In most cases, the instructional methods were changed for the block classes, while the assessment methods were maintained. The hybrid teachers were able to reflect and compare their

Table 3
Course GPA data for four hybrid science teachers.

Hybrid Teacher	Course	Schedule Type and Course Number	Course GPA
Redox	General Chemistry	Traditional – 6101	2.68
		Block – B6101	2.77
Ballistic	General Physics	Traditional – 6111	2.80
		Block – B6111	3.06
Kelvin	General Physics	Traditional – 6111	3.03
		Block – B6111	3.00
Kreb	General Biology	Traditional – 6003	2.26
		Block – B6003	2.41

teaching methods in block and traditional classes. "I feel that I have achieved more in my block classes than in my traditional classes because I have the opportunity to devise new methods of presentation" (chemistry interview). A hybrid physics teacher felt that the direct comparison brought about a rushed feeling which was due to the lack of content presentation. "I can't cover as much as I can in traditional. Because of this, I have to lecture more than I want." The block classes had a higher GPA compared to the traditional classes, because the students learned less content in a more intense or accelerated manner. Sometimes the accelerated manner was due to "streamlining" the curriculum content.

Science Student Data

Several data were recorded for science students. The first set of data gives background information on the type of student that enrolled in classes within a particular schedule. The data in Table 4 represent descriptions of students in the year prior to implementation of the tri-schedule and the first year of implementation. The data represent the entire student body and are not limited to science.

Table 4
Descriptive Statistics of GPA by gender and schedule for academic years 1996-97 and 1997-98.

	Traditional	**Block**	**Hybrid**	
Year 1996-97 GPA				Total
Male (N = 469)	2.84	2.54	2.68	2.75
Female (N = 415)	3.15	2.99	3.40	3.14
Total	2.98	2.79	2.99	
Year 1997-98 GPA				
Male (N = 469)	2.71	2.75	2.92	2.76
Female (N = 415)	2.96	3.02	3.24	3.02
Total	2.82	2.88	3.07	

Females performed significantly better than males in 1996-7 and 1997-98, regardless of schedule type. ($p=0.000$, $F=22.908$, $df=2$, $\alpha=0.05$ for 197-98) Students who elected or were placed in the block schedule had a significantly lower GPA in the year prior to implementation

than students in the traditional and hybrid schedules. ($p=0.005$, $F=5.299$, $df=2$, $\alpha=0.05$) During the year of implementation, students who were in the block and hybrid schedules out-performed their traditional counterparts. Hybrid students performed significantly better than the traditional students. ($p=0.003$, $F=5.299$, $df=2$, $\alpha=0.05$) Males did perform better in the hybrid and block schedules than in the previous year. The male students performed the worst in the block schedule. Males entering the 1997-98 school year improved their GPA in both the block and hybrid schedules.

The second set of grade data is the breakdown of grades by science course. The perceptions of the students and parents that students' grades in block classes had improved were validated by the comparison of grades for traditional and block classes. In three out of the four courses, block classes had a higher percentage of A's. Biology and chemistry had a higher percentage of B's in block classes. All block classes in all of the courses had fewer failing grades. The higher achieving students did well in the block classes, while the weaker students had fewer failures. The average student did better in biology classes, while the physics and chemistry students performed equally well. Grade inflation was ruled out as a basis for an increase in block schedule results due to the number of hybrid teachers who did not differentiate their assessment between bock and traditional classes.

Table 5
Number and percentage of students and their grade breakdown for science courses.

Grade	**A**		**B**		**C**		**D**		**F**		**Total**
Applied Biology											
6000	5	18%	9	32%	4	14%	7	25%	3	11%	**28**
B6000	9	33%	4	15%	9	33%	3	11%	2	7%	**27**
Total	14		13		13		10		5		
Biology											
6002	38	23%	37	22%	41	25%	25	15%	25	15%	**166**
B6002	24	15%	45	29%	52	34%	27	17%	7	4%	**155**
Total	62		82		93		52		32		

Chemistry											
6100	32	25%	47	36%	24	18%	17	13%	10	8%	**130**
B6100	31	35%	30	34%	15	17%	10	11%	3	3%	**89**
Total	63		77		39		27		13		
Physics											
6110	43	27%	50	31%	34	21%	21	13%	12	8%	**160**
B6110	57	41%	43	31%	30	22%	6	4%	3	2%	**139**
Total	100		93		64		27		15		

Semester Exams

Semester exams were used instead of standardized tests because there were no pre-existing state, district, or department wide subject tests, and faculty did not want their entire test to be based upon a common set of questions with a specific format. Many block classes did not cover as much content as traditional classes, thus fewer questions were asked than originally desired. In essence, these semester exams acted as standardized tests since all subject teachers decided on the content to be included and the questions to be asked. Comparable class pairs were biology, chemistry, and physics. The last year's GPA for block and traditional students in applied biology was not close enough to make a direct comparison. Students in the block classes had a higher percentage of correct answers on semester exams than their traditional counterparts in all of the comparable class pairs. In all block classes the students outperformed their traditional counterparts based upon common content topics and concepts that were jointly covered by both class types. It should be noted that some block classes did not cover as much content as the traditional classes. It can be implied that students learn science better in an intense environment with fewer classes to take and learning less content than in a traditional course.

Table 6
Semester exams in science courses with number and percent of correct responses.

Subject	Last Year's GPA for Students in Course	No. of Students	No. of Questions	Average Number of Correct Responses	Percent of Correct Answers
Applied Biology Trad.	2.27	59	45	26.5	58.9
Applied Biology Block	1.89	59	45	27.8	61.7
Biology Trad.	2.91	184	30	20.6	68.7
Biology Block	2.93	179	30	21.6	72.0
Chemistry Trad.	3.28	135	24	17.0	70.8
Chemistry Block	3.26	102	24	17.6	73.3
Physics Trad.	3.25	170	40	30.1	75.3
Physics Block	3.28	146	40	31.9	79.8

Discussion

The results reported above offer qualified support for the argument that block scheduling can serve as an impetus for change. In the teacher survey results, where significant differences were found, and student achievement data the differences were aligned with what this argument would predict; that is, traditional teachers reported less change than block or hybrid teachers. However, when reported changes were examined within the broader context of teaching, the results of this study are more difficult to interpret. In particular, while teachers reported some of the benefits addressed in the research literature on block scheduling, they also reported challenges, tradeoffs, and obstacles to improving their classroom practices. Not only were there positive changes, but there were also negative changes as a result of block implementation.

Content Coverage

In addressing the issue of content coverage, parents, students, and teachers repeatedly commented on the pace of their instruction, demands on teaching in general, and demands on class time in particular. Thus, while change in general was associated with the teachers' overall workload, increased pace of instruction was explained specifically by the need to cover a set amount of course content. Content decision making, especially content exclusion, has not been widely addressed in the literature on block scheduling. Yet, content was the paramount issue for

those teachers in our study who reported the hazards rather than the benefits of block classes. In particular, all the physics teachers felt a need to cover more content than they were able to in the shortened block schedule. The teachers who identified criteria for eliminating course content may shed some additional light on this issue. On the one hand, criteria related to school and state testing and perceptions of what students will need for other courses suggest that content beliefs are connected with the basic structures of schooling. Teachers, in short, did not work in a vacuum. On the other hand, teachers also suggested that their reluctance to eliminate content was rooted in their conceptions of teaching and what it meant to be a teacher. On this point, content seemed connected to both the structural context of schooling and the professional beliefs of teachers.

It's the teacher, not the schedule

The teachers in this study reported at least two changes that are often considered to be among the potential benefits of block scheduling. Teachers noted the first benefit in the context of increased variety of instruction. Specifically, teachers offered examples that represented a move toward more student-centered instruction. These reported changes included a more frequent use of projects, cooperative group learning, and individualized forms of instruction. The second benefit focused on improved student-teacher relationships. Some teachers also connected this benefit with an overall improvement in classroom climate. Positive changes in both interpersonal and group dynamics were largely attributed to working with fewer students, longer class periods in which to get to know students, and more opportunities for individual attention.

Of course not all teachers reported these benefits. On the contrary, some teachers indicated that block scheduling had opposite effects on their day-to-day work. Teacher- and subject-centered methods of instruction were noted in some classes by the more frequent use of lectures

and handouts. These results produce a seeming contradiction between the benefits and hazards of block scheduling. A partial explanation for such conflicting reports was found in the multiple, and sometimes competing effects of block scheduling on practice. One effect in particular, the increased pace of instruction, stood out because teachers mentioned this effect in all four areas of the teacher surveys that showed significant differences; teaching methods, anxiety level, assessment, and relationship between teacher and student (see Table 2).

The change in schedule did effect some of the pedagogical methods employed by the teachers, but it was the idea and opportunity for change that allowed certain teachers to explore new instructional methods on their own. The schedule change did initiate discussions about content coverage, pace of instruction, and instructional methods, but change did not occur unless the individual teacher initiated it themselves to make the transition and accommodate the new parameters. The transition included developing alternative assessment methods, re-formulating the textbook based content, and altering instructional methods; especially with small class sizes and in some cases increasing lecturing.

There was a ripple effect from the block and hybrid teachers to the traditional teachers. Many of the traditional teachers mentioned that they had started to apply many pedagogical concepts that were discussed with or used by the block class teachers. The need to limit the content and develop common test questions caused the science department and science discipline teachers to communicate more often and efficiently. The traditional teachers often had "lab envy" because the block teachers could complete an entire lab in a day. This effectively produced discussions about appropriate methods of teaching labs, and how labs could be re-written to enhance learning of specific concepts.

Reflection-on-Action

The hybrid teachers had a unique opportunity to compare what they taught in one course to the same course only in a different format and pace. The hybrid science teachers did mention that they were able to develop and integrate more advanced ideas into their traditional classes at an earlier time in the semester. As long as teachers communicated with their colleagues and did not isolate themselves in their classrooms, teachers implemented new teaching methods. The teachers increased their use of explicit and connecting analogies, examples, and problems to teach new concepts. For example, a chemistry hybrid teacher defined compounds as strong or weak acids rather than just sulfuric or acetic acid when instruction focused on naming compounds. In essence, he knew from teaching acids and bases to block students that they did not have a good level of prior knowledge on acids and bases. Specifically, naming the compounds early in the year as strong and weak gave the students this prior knowledge.

With respect to methods, the more frequent use of lectures was explained as "a quicker way to cover materials." Teachers reported that reflection was less manageable with "little time to pause." Hybrid teachers reflected on their teaching methods and content more efficiently and quickly than if they were only teaching in a year-long traditional schedule. What was learned in the accelerated block class was applied to the traditional class and the second block class more readily. This method effectively eliminated the year long waiting period that many teachers have when implementing a new idea discovered through reflection on their actions. Schon (1983) stated that teachers learn better and implement new teaching strategies when they reflect-on-action. The hybrid schedule decreased the amount of time between reflection-on-action and implementation.

Implications for Teacher Education

The final section focuses on the implications of this research for pre-service teacher education. Although models of teacher education differ in substantial ways, they typically share two goals. The first goal is to prepare future teachers to perform the tasks that schools expect them to perform. The second goal is to prepare future teachers to improve schools by actively participating in educational reforms. What teacher education programs can do to help future block teachers successfully meet these goals is the question to be answered.

The first goal of teacher education is guided by the practical demands of teaching. Given the changes in classroom practice reported by the teachers in this study, block teachers face greater demands to use a variety of instructional methods within and across class periods. This finding suggests new opportunities for teacher educators to address teaching methods (especially methods that involve hands-on learning and simulations) that may have once been considered impractical due to the time restrictions imposed by traditional, 50-minute class periods. Expanding the repertoire of teaching and assessment methods that teachers bring to their work is an important task because different methods require different skills as well as a conceptual understanding of how these skills fit together in practice. Moreover, the very notion of a repertoire implies the critical knowledge of not simply how to use methods, but also when to use them and to what ends they are best suited. Situational and content specific methods of teaching imply a development of these characteristics in the preservice program. The how and when aspects become the focal points for pedagogical content knowledge as a theme for preservice education.

One potential learning situation which might enhance greater understanding of methodology faster is to place a student teacher in a hybrid schedule. This schedule would encourage the

student teacher to directly compare content and pedagogy used in longer class periods and shorter year-long classes to traditional classes. The longer classes would provide the opportunity to experiment with different teaching styles while examining the content for applicability and compatibility.

Increasing the teachers' repertoire of instructional methods is one of the primary findings of this study. Interpretation of the data of the study also suggests that this ability alone will not ensure that block scheduling works to the advantage of students. As in the case examined here, the most common forms of block scheduling reduce the total contact time between teachers and students for any given course. The evidence suggests that increasing the pace of instruction in response to this aspect of block scheduling will undermine its benefits. For this reason, content decisions take on renewed importance. It was not surprising to learn that these decisions were often left in the hands of individual teachers. Yet, a related finding was unexpected. Specifically, teachers reported using criteria for content exclusion that rest largely outside their own judgments of what knowledge is most relevant and most worth learning. In essence, district and state standards guided their decision making. The implication for teacher education is that preservice teachers should be knowledgeable about state and national standards, and their implications for classroom practice.

On the issue of content, the questions for teachers and teacher education are twofold. First, how can future teachers be prepared to make the difficult decisions that shape their own curriculum? Should teachers rely entirely on state and national proficiency guidelines, college entrance exams, and the like? If not, what alternative criteria should inform these decisions? What guidance do curriculum theory, educational philosophy, and debates within specific subject areas offer in this context? Second, when are traditional, subject-specific conceptions of

secondary teaching inadequate to inform practice? In other words, when is content an obstacle to good teaching? To avoid this danger, can future teachers be prepared to productively challenge views of content coverage that others often take for granted? Ultimately, how well do teacher education programs model school reform that effects classroom science teaching and learning?

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