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Analysis of the Block Scheduling System and Its Effect at Leicester High School

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By

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Abstract

This study analyzes block scheduling and its effect on Leicester High School. Block Scheduling is a system where fewer, but longer classes are employed. The effects of block scheduling were investigated through analysis of SAT scores, student surveys, and faculty surveys. Although this study found no relationship between scheduling systems and SAT scores, student and faculty surveys revealed a great deal about block scheduling at L.H.S. It was recommended that a five period schedule be adopted.

1. Introduction

Over the past five years, Massachusetts's schools have undergone a dramatic change from a traditional schedule to a block schedule. A block schedule is a schedule where you have less than 5 classes a day usually around 90 minutes each, while a traditional schedule has more than 5 classes a day around 50 minutes each. With the advent of the Massachusetts Education Reform Act of 1993, schools were forced to have 990 hours of structured learning time per year. Previously, there was no set hours for structured learning time. Schools were expected to be in attendance for 180 days, with classes lasting six and one half hours each day. The only way to meet the required 990 hours, without extending the school year/day, was to have longer class time. Block scheduling was a popular solution to meet these requirements. One of the schools to adopt block scheduling in the last five years is Leicester High School. Leicester High has shown concern over the block schedule implemented in 1994. Leicester's concerns are justified since some studies have shown block scheduling to have adverse effects on math and science classes. This study hopes to find better ways to deal with these possible adverse effects.

To help Leicester solve their scheduling problems, this project will analyze SAT scores and the results from student and faculty surveys. This study hopes to look at the difference between the various scheduling systems and find the best solution for Leicester.

If what proponents of block scheduling say is true, both math and science should receive the most benefit from block scheduling. These added benefits should help give students the extra background needed to more easily excel in the demanding fields of science and technology.

Worcestor Polytechnic Institute's Interactive Qualifying Project concentrates on the interaction of science and technology and how it relates to society. Technology does not necessarily refer to just "nuts and bolts", it can mean the techniques used to manage or evaluate a resource efficiently. In this case, time is the resource and we are trying to manage it efficiently through the techniques of scheduling.

2. Literature review

2.1 State of The Art

2.1.1 What is Block Scheduling.

Block scheduling is a scheduling system that differs from the traditional six to seven 50-55 minute periods a day. It's a system that puts emphasis on having fewer classes, but longer classes per day. Generally these longer class times, referred to as "blocks", are typically around 80-90 minutes long and meet 4 times a day.

The block scheduling system can bring with it both positive and negative effects to the classroom. It has been theorized that by using a block scheduling system, students will gain more in depth study, teachers will use more varied teaching styles and both students and teachers will benefit from less stress. However, it has also been suggested that a block scheduling system will make it harder to maintain students' attention, there will be less coverage of material, and the time lag between sequential subjects will hurt student learning. Therefore, in theory, block scheduling can produce beneficial results over a traditional system but not without costs. Previous studies, such as the North Carolina Study and the Canadian studies have tried to explore these costs and benefits and can be found in section 2.3.

There are numerous variations of block scheduling, but most of them usually fall under a few general block-scheduling models. Some of these general block-scheduling models include the 4x4 Block, the Alternating Block, the Copernican Plan, and the San Francisco Urban Plan. The distinguishing features of the scheduling systems will be explained later in section 2.2.2.

Block scheduling is being used to restructure the school schedule in order to increase structured learning time. This is the time in which students learn under the direct guidance of a teacher and excludes such things as recess, study hall, extracurricular activities, etc. Increasing structured learning time with block scheduling will allow Massachusetts schools to be up to date with prevailing norms in advanced educational institutions and will give more time for students' educational needs. This and the fact that block scheduling allows students to take more classes with a larger variety makes it a compelling choice over the older traditional schedules. Some of these other benefits along with some of the costs of using block scheduling will be discussed later on in the text.

2.1.2 The Massachusetts Education Reform Act of 1993

The Massachusetts Education Reform Act of 1993 is one of the only state laws in Massachusetts to set up statewide educational standards. Prior to 1993, the only statewide education laws in Massachusetts regarded physical education and history. To improve students education, the reform act set forth the creation of statewide curriculum frameworks and learning standards for all students in all the core academic subjects. It also established improvements in school management, teacher professionalism, and equity of funding.

In relation to this project, the reform act states that the Board of Education has to prepare a plan to expand the time during which students attend school. The reform act doesn't define how much structured learning time must be expanded. Instead, it states that the Board of Education must devise a plan to increase learning time. This led the Board to eventually define the amount of time students spend in class, excluding extracurricular activities and other non-instructional activities, such as lunch and recess, to be 990 hours per school year. Prior to this, the mandatory school year was 180 days and was not defined in hours of structured learning time. Due to the amount of time that didn't consist of structured learning time in the traditional schedule, it wasn't possible to reach 990 hours without some changes. Therefore, the increased amount of structured learning time required, plus factors such as teachers contracts, and the desire to have an overall better education system, led to the adoption of various forms of block scheduling around the state.

Though proponents of block scheduling claim that the benefits outweigh the costs associated with it, others disagree. Some believe that there are costs of block scheduling that will outweigh the alleged benefits, thus making it ironic that a law aimed at improving education created a need to adopt a schedule that can hurt it. This study hopes determine if the various scheduling systems that resulted from the education reform act are effective in creating a better learning environment for the students.

2.1.3 The Need for Block Scheduling in Massachusetts.

Due to various factors, many Massachusetts high schools found it necessary to adopt a block scheduling system. Some of the factors that encouraged the change were the reports of improved students' attitudes, more student/teacher interaction, and less wasted class start-up time. However, the two main reasons that practically forced schools to switch to a block schedule were the mandatory increase of structured learning time and a problem with current teacher contracts.

One of the main factors for adopting block scheduling is due to the increased structured learning time. Through various forms of block scheduling, it is possible to increase this learning time without increasing the school day or the school year. Most of this added time comes from the decreased number of passing times between classes. By having only four classes a day under a typical block schedule, the school day will only have 3 passing times as opposed to the 5 or 6 passing times in a traditional schedule. Assuming that a standard passing time is five minutes long, a traditional schedule loses between 25-30 minutes of the school day due to it. On the other hand, a typical block schedule loses only 15 minutes a day to passing, allowing an extra 10-15 minutes more learning time per school day than the traditional schedule. Seeing that block scheduling adds around an hour and fifteen minutes more class time to the normal school week makes it an appealing solution to meeting the new 990 hour requirement.

The second major factor in adopting block scheduling involved a problem with teacher contracts. Some would consider it to be easier and more beneficial to meet the 990-hour requirement by just expanding the school day or the school year. Unfortunately, most current teacher contracts do not allow for the extra time that would be needed to do this. Teachers not fond of working longer hours without compensation would not work these extra hours without a new contract. However, schools did not want to change and make a substantially large amount of new teacher contracts. This brought schools to believe that block scheduling was the best solution available.

Considering these two main factors, along with the other alleged benefits inherent with block scheduling, many Massachusetts High Schools were convinced it was the best solution for them. This led to a number of high schools across the state to adopt and modify the various forms of block scheduling to meet their particular needs. This led us to the current state of the scheduling systems in Massachusetts and left some wondering if block scheduling really is the best choice for students' education.

2.2 Scheduling Systems

2.2.1 The Traditional Scheduling System

A schedule that is on a traditional timetable generally has six to seven classes that run for 45-50 minutes a day, for the entire school year. The classes might be on a rotating block, with a schedule that might look like this: Day 1 – ABCDEF (where the different letters correspond to class blocks), Day 2 – BCDEFA, Day 3 – CDEFAB, Day 4 – DEFABC, Day 5 – EFABCD and Day 6 – FABCDE. This example refers to a school having six classes a day. Once the six day rotating schedule is completed, you would go back to "Day 1," where the A block would be first again. This cycle would continue for 180 school days. This schedule could also be used for seven classes, which would work on a seven day rotating schedule. Obviously, a school could run six or seven classes, having class at the same time every day for the whole year. The class blocks would not rotate, and classes might run ABCDEF every day for the entire year.

2.2.2 Types of Block Scheduling

There are four categories of block scheduling in existence today: 4X4, (4X4 A,B), The Copernican Plan, and the San Francisco Urban Plan.

In the 4X4 plan, all standard year-long classes from a traditional schedule are converted into half-year long courses of 90-minute classes. A student takes a total of four classes each day. The teachers teach three classes per day with either a 90-minute prep period or a 45-minute prep period and a duty. At the mid-year point, around January, the students and teachers change over to a new schedule. In some situations, there may be a class that runs for an entire year, which meets for 90 minutes each day. When this occurs, there obviously would be no changeover to a new class at the halfway point.

The 4X4 A,B plan is very similar to the 4X4 plan. The only exception is that every other day you have four different classes. The student is carrying eight classes for the entire year.

In the Copernican Plan, a student has just two classes per day. The classes meet for 180 minutes and are completed in just 30 school days. At the end of the 30 school days, the students and teachers change over to a new pair of classes.

In the San Francisco Urban Plan, there are three semesters of 12 weeks each. In this type of block scheduling, students would take 12 classes in an academic year. What was a year-long course in a traditional schedule is covered in 24 weeks under the San

Francisco Urban Plan. Therefore, the five core courses, math, science, history, foreign language and English, would make up ten of the twelve courses taken during the year. The other two classes might be taken in music, physical education, art, etc. This schedule is also very similar to the 4X4 plan, as classes run for 90 minutes each.

Of course, there are numerous variations on the schedules listed above. For example, in a 4X4 plan a school might have a day set aside each week where only two classes would run for 180 minutes each.

2.2.3 The Five Period Schedule

The Five Period Scheduling system is a system that falls in between the definitions of Block Scheduling and the Traditional system. This system is somewhat of a hybrid of the two that operates with only five periods per day. In some variations of this scheduling system, the four of the five periods range in duration from 45 to 50 minutes a day. This variation takes the remaining period and extends it to around 90 minutes. This fifth period can prove useful for teaching science classes with labs or any other subject that is felt to benefit from an extended period. Depending on the needs of a school, many other variations of this schedule may exist, differing in the duration of its classes and by sometimes rotating the classes in the schedule.

2.2.4 Scheduling System Break Down

Below is a table of the breakdown of how many schools are using a particular schedule according to our survey, which will be explained later in section 3.2.3. From this, we can see that the majority of schools that responded still use a traditional scheduling system.

Traditional	5 Period	4x4	4x4 AB	Copernican	San Fran Urban
82	8	35	15	1	0

2.2.5 Pros/Cons of Block Scheduling

There are a number of points that have been made in support of and in opposition to block scheduling. The following are some of the more noteworthy ideas. Those who support block scheduling say there is a greater amount of time for student-teacher interaction. They also point out that instructors can use more varied teaching styles. With a longer class, the hope is group work, multimedia applications (computers, TV, and VCR), discussion, and hands-on projects will be employed. In theory, by using these different styles, there will be a stronger student-teacher bond than if a lecture format was used.

Other reasons for block scheduling include less time lost in the halls between class and more class time due to less start up times at the beginning of class. In a traditional six period schedule there would be five breaks between classes (including lunch), but only three breaks for a 4X4 schedule.

Proponents of block scheduling also say that there is more room for advancement by motivated students. For example, a student wanting to get ahead in math might be able to take four different math classes in two academic years. A student at a school with a 4X4 schedule could take Algebra, followed by Geometry, Algebra II and Pre Calculus/Trigonometry. This might allow the student to take advanced math courses at a local college during their junior or senior year.

Others have contended that there are reduced drop out rates, less stress, better grades and fewer failures. This could be a result of classes in a block schedule being easier than classes in a traditional schedule.

Opponents of block scheduling argue that students have short attention spans and cannot concentrate for 90-minute blocks (180 minutes in Copernican). Unless the subject is sex, violence, drugs, or rock n' roll an adolescent will lose interest after a period of time.

Another major problem is the layoff between sequential subjects of up to a year. In a 4X4 schedule, a student may take a course in the first semester of one year and not take the sequel until the second semester of the following year. This can be particularly difficult in math and foreign language courses. As a result of this problem, a great deal of time has to be spent in review of the subject matter.

With the advent of block scheduling, study halls were eliminated. Unfortunately, this was a time where students could use the library, make up tests, get extra help, and socialize with friends.

Another issue brought up against block scheduling is the loss of class time. Opponents argue that there is a loss of total time in core subject areas of 8%. In a 4X4 schedule, classes meet for 90 minutes a day for a half year. However, in a traditional schedule classes meet for 50 minutes a day for an entire year. This value adjusted is 100 minutes a day, as compared to 90 minutes a day. Factoring in the extra time for class start up, a figure of 8 % is obtained.

One fault that lies in block scheduling is that students are often allowed to do homework in class. With the longer blocks, instructors often give students 10-20 minutes of "free time" where homework can be done. The extra time may be allowed because the instructor has been lecturing for over an hour, and feels the class is no longer paying attention. Proponents of block scheduling say that instructors should use more varied teaching styles. Unfortunately, this does not always occur, and students are forced to sit through long lectures.

Another problem that has been brought forth is student absences. When students miss a class in a school using a 4x4 schedule, they can fall behind in a subject. Remember, that one class in a 4x4 schedule is roughly equivalent to two classes in a traditional schedule. If a student misses two straight days of class, this situation is further compounded.

2.2.6 History of the Scheduling Systems at L.H.S. in the 1990's

From 1990-1994, Leicester High School had a seven class rotating schedule that ran for the entire year. Students would take five core courses, consisting of math, science, foreign language, English and history. These classes would run 45-50 minutes every day for the entire school year. There was one class period that included physical education, health and an elective (usually study). Recalling from a Traditional Schedule, a rotating class schedule of seven classes ran for a seven-day period. At Leicester High School, a student might have physical education on Day 1, Day 3 and Day 5. Health might fall on Day 2, Day 4 and Day 6, and the elective class might be on Day 7. The remaining class was an elective, where a student could choose from study, wood-shop, art, computers, etc. To round out the time in school, students would have a homeroom period in the morning and a half-hour lunch.

In response to the Education Reform Act, Leicester implemented a transitional schedule in 1994-1995 to bridge the gap between a traditional and block schedule. Instead of a seven-class rotating schedule, a six-class rotating schedule was utilized. The elective class was eliminated. Students had five core courses and the block containing physical education, health, and a study.

In the fall of 1995, Leicester High School implemented a 4X4 block schedule to conform with the 990 hours required of students for the academic year. Four classes run 90 minutes a day, for half an academic year. At the midway point in the academic year, students change over to four new classes. The only exceptions to this are Introductory Algebra I and Advanced Placement classes, which are held 90 minutes a day for the entire year.

2.3 Previous Research

2.3.1 Why These Studies are Important

There have been numerous studies done on block scheduling in North America over the last 20 years. The reason we chose the North Carolina Report and the Canadian Studies is because they are regarded in education circles as the best studies done on block scheduling. Part of the reason the Canadian studies are so respected is because they have withstood the test of time. Two of the papers were written in 1986, another in 1990, and the fourth in 1997. People have had a long time to find fault with these works. It is a credit to the research papers that no major arguments in opposition have come forth.

The studies are also highly regarded because they are composed of a large amount of data. Generally, the more data you have, the better the study. In the North Carolina Report, for example, the scores from students for every school in the state (over 350), were used to analyze the effects of block scheduling. In Canada, the Bateson study had over 28000 student scores. The following is a "road map" to the four Canadian studies and the North Carolina Report:

STUDY	YEAR PUBLISHED	STATE/ PROVINCE	STUDY COVERS		EXAM USED	YEAR OF EXAM
			EXAM	SURVEY		
Raphael, Wahlstrom and McLean study	1986	Ontario	X	X	Second International Math Study (SIMS)	1982
Raphael and Wahlstrom study	1986	Ontario	X	X	Second International Science Study (SISS)	1984
Bateson Study	1990	British Columbia	X	X	Provincial Exam For Science	1986
North Carolina Study	1997	North Carolina	X	X	End-Of-Course Test (EOC)	1993-1996
Gore Study	1997	British Columbia	X		Provincial Exam	1996

2.3.2 The North Carolina Report

One of the major studies that has been done on block scheduling is the North Carolina Report. This report is generally regarded as the most comprehensive study done on block scheduling in the United States. The study tried to determine if there was any benefit to block scheduling over traditional scheduling by looking at student test scores. The study also surveyed student attitudes and opinions about class schedules to see if there is a preference for block scheduling or traditional scheduling.

In 1992-1993, 6 out of 371 (1.62%) schools in North Carolina used block scheduling. The following year, 31 more schools adopted block scheduling. In 1994-95, 130 schools were on "the block." By 1995-1996, the number had grown to 207 out of 371 (55.8%) schools on block scheduling. The North Carolina report considers a school to be on a block schedule if they are using a semester (4X4) timetable.

This study involved looking at End-of-Course test results (EOC) for blocked and non-blocked schools. The End-of-Course Test is given in each subject, and a student must pass the test to get academic credit. The five subjects that were considered in this study were English I, Algebra I, Economics and Political Systems, Biology, and U.S. History.

Since types of scores used in EOC tests had changed over the years, all EOC scores were converted to a common scale – standard t-scores - for meaningful comparisons. What "types of scores" means is the test might be on a scale of 0-80 one year and then 0-100 the next. Analysis of variance was used to compare mean t - scores between the two groups. The only problem with this comparison is it fails to consider other variables. For example, a school's performance prior to block scheduling will influence EOC test scores regardless of the schedule used. To take into account the "starting point," or the scores of schools prior to block scheduling, an average was taken. For example, in a school starting block scheduling in 1995, the average of 1993 and 1994 EOC test scores was used. The socio-economic status of the students is another factor that must be considered. To deal with this variable, a question on the EOC asked the students what level of education their parents attained.

The adjustments for Parent Education Level and starting point were justified statistically. In general, a better statistical model is found when more of the variance between two groups can be accounted for. In the original comparison, where no adjustments were made, only .10% to 4.4% of the variance could be accounted for. However, when the Parent Education Level and starting point adjustments were added, 54%-74% of the total variance could be accounted for.

When all of the data was correlated and analyzed, it was found that there were essentially no significant differences between blocked and non-blocked schools. This is not to say there were no differences between mean scores, only that there were few significant differences.

After analyzing test data, and finding no conclusive results either way, the North Carolina Board of Education decided to look at attitudes and opinions towards block scheduling. The second part of the North Carolina Report examined survey results from principals, teachers and students in a sample of 25 4x4 block scheduled high schools.

After analyzing the survey, it was found that principals, students, and teachers are satisfied with block scheduling. Principals are the most positive, followed by teachers, and then students about block scheduling. However, block scheduling is not unanimously favored. One-sixth of teachers and one-fourth of students prefer a traditional schedule.

To better gauge student surveys, the North Carolina report divided the data into strata by Grade Point Average (GPA). Students with average or above average GPA's (2.00-4.00) were found to be more significantly satisfied with block scheduling than students with lower GPA's (less than 2.00). To further support these results, teachers rated block scheduling as best for above average students and least effective for below average students.

While test results could not indicate a difference between blocked and non-blocked schools, survey results point to a preference in block scheduling. It is a good idea to consider student opinions and attitudes when deciding on a schedule, but it should not be the most important factor when comparing schedules. Students might find a schedule more favorable than a previous schedule because less work is assigned or topics are not covered in as much detail. Because student attitudes and opinions can be biased, they should be weighed accordingly.

2.3.3 The Canadian Studies

2.3.3.1 The Raphael, Wahlstrom, and Mclean Study.

The study by Raphael, Wahlstrom, and Mclean, set out to see if there was any truth to the positive claims of semester scheduling for secondary schools. To do this, they conducted probability samples of various Ontario secondary schools and used results from the "Second International Mathematics Study" to measure performance.

The Second International Mathematics Study was the second international comparative achievement test in the subject of mathematics. This study did more than measure academic ability. It tried to examine students' attitude, socio-economic status, the amount of curriculum resources in the classroom, and information on the teachers. These goals were met through the use of a mathematical achievement test as well as surveys and elaborate questionnaires given to both the teachers and students.

The sample that was used for Raphael, Wahlstrom, and Mclean's study was composed of 250 classrooms from 80 different Ontario schools. Ninety-four of these classrooms were following a semester style scheduling system. This allowed them to obtain achievement and attitude data for a total of 5280 students.

To measure the students mathematical abilities during the Second International Mathematics Study, one hundred and thirty-six questions were chosen by an international committee to be put on the SIMS (Second International Mathematics Study) test. These questions were then categorized into 27 different sections by topic. From these 27 topics, thirty-four questions were randomly distributed and answered by students. During the 1981-82 school year, the students were given two periods at the end of their mathematics course to complete the 34 questions. Raphael, Wahlstrom, and Mclean used questions from only eleven of the 27 topics in their study.

From analyzing the results from the SIMS, it was shown that there was a significant difference in the scores on most the different topics. It was shown that students in full-year classes usually had a significantly better score in most the mathematics topics and in the topics that they weren't significantly better, there was shown to be no significant difference between the two.

To try to take into account various background variables such as socio-economic status, the students were asked to describe the occupations of both of their parents. From these descriptions, they tried to evaluate if there was any difference between the socio-economic backgrounds of students in semester scheduling and full-year scheduling. Their results indicated that there was no statistically significant difference in the socio-economic backgrounds of the students in semester and full-year scheduling.

The study then took into account such factors as the amount of experience the teachers had teaching. When looking into this factor, they saw that teachers in the semester scheduling system had significantly fewer years teaching.

A greater variety of teaching techniques and material is often claimed to be used by semester classes. To evaluate the truth of this claim, teachers reported how often they used each of seven materials in class: textbooks, workbooks, individualized materials, commercially published tests, self-prepared teaching materials, and teacher-made tests. From analyzing these reports, it was found that teachers in semester scheduling were more likely to use workbooks, individualized material, and visual materials. It was also observed that the teachers with more teaching experience had a higher use of visual aids than teachers with less experience. From this, it was concluded that the prediction of semester classes using a larger variety of teaching materials were true, though they don't believe these differences are very large

They next tried to see if there was any claim to improved student attitudes towards course material, in mathematics. Through a survey on the students, it was shown that the prediction of a better attitude towards course material through the use of semester scheduling was false in relation to mathematics. Through analyzing the results of this survey, it was shown that students under the semester scheduling system had a less positive attitude towards the material than students in the full-year scheduling system.

The study came to the conclusions that even though there may be reasons to switch over to semester style scheduling, there was no apparent benefit from it in relation to mathematics courses. Instead of increased performance in the subject material as advocates of the semester style schedule proclaim there is generally a decrease in performance. They also saw that students' attitudes were unchanged or slightly decreasing in the semester format. Though some of the decreased performance in mathematics may be related to the over-all less experience by teachers in the semester system, its influence is considered to be small when compared to the sum of all the effects of all the other variables that can come into play. In conclusion, Raphael, Wahlstrom, and Mclean believe that even though there may be benefits from semester style scheduling, there is no compelling reason to switch over to it for mathematics classes.

2.3.3.2 The Raphael and Wahlstrom Study.

In The Semestered Secondary School and Student Achievement: Results from the Second Ontario International Science Study (SISS), Dennis Raphael and Merlin Wahlstrom looked at the effects of block scheduling on scores from the SISS test. Schools were divided into semestered and full-year timetables, while mixed systems were excluded.

Students from 75 schools answered 35 questions in biology, chemistry or physics, depending on which class they were enrolled. There were 1297 students who took the biology exam, 1277 who took the chemistry, and 1210 who took the physics test. Since not all three class types were tested within all the schools, an F test and analysis of variance procedures were used to test the significance of the results.

As part of the test, students were given statements pertaining to attitudes towards science. Students had five response options, ranging from strongly agree to strongly disagree. The statements posed to the students were:

- Biology (Chemistry, Physics) is an enjoyable school subject
- Biology (Chemistry, Physics) taught at school is interesting.
- Biology (Chemistry, Physics) is difficult
- Biology (Chemistry, Physics) is relevant to everyday life.

Forty-three schools contributing biology data were nonsemestered, while 19 were semestered. Nonsemestered schools were found to have a mean of 47.9 and a standard deviation, or spread, of 6.3. The semestered schools had a mean of 44.8 and a standard deviation of 6.9. When an F test was used on the data, the results showed that students in nonsemestered schools significantly outperformed those students from semestered schools. However, when results of the student attitude statements were examined, the test for significance suggested differences in favor of the semestered schools for two items: "Biology is an enjoyable school subject" and "Biology taught at school is interesting."

Forty-five schools contributing chemistry data were nonsemestered, while 21 were semestered. Nonsemestered schools were found to have a mean of 41.2 and a standard deviation, of 6.9. The semestered schools had a mean of 38 and a standard deviation of 8.2. When an F test was used on the data, the results showed that students in nonsemestered schools significantly outperformed those students from semestered schools. However, when results of the student attitude statements were examined, the test for significance suggested differences in favor of the semestered schools for two items: "Chemistry is an enjoyable school subject" and "Chemistry taught at school is interesting."

Forty-one schools contributing physics data were nonsemestered, while 18 were semestered. Nonsemestered schools were found to have a mean of 40.2 and a standard deviation, of 6.4. The semestered schools had a mean of 39.8 and a standard deviation of 4.5. When an F test was used on the data, the results showed that there were no significant differences between the two mean scores. When student attitudes were examined, it suggested differences in favor of semestered schools for two of the items: "Physics taught at school is interesting" and "Physics is relevant to everyday life."

In conclusion, this study shows that schools using a semestered style school schedule scored significantly lower on two of three subject areas when compared to schools using non-semestered schedules. This indicates that, in terms of SISS scores, semester style block scheduling systems, such as the 4x4 block, can hurt student performance in such subjects as Biology and Chemistry. In contrast, however, the attitude findings from SISS indicated that students in semester courses project more favorable attitudes towards science. It is obviously important for students to have a positive attitude towards school, but is necessary that the students perform up to their potential on tests.

2.3.3.3 The Bateson Study.

In the article, Science Achievement in Semester and All-Year Courses, David Bateson investigates the effects of full credit semester (4X4) and full-year timetables on science achievement. Bateson looks at scores of 10th graders from the May 1986 Third Provincial Assesment of Science. Students were randomly given one of three tests by the British Columbia Ministry of Education.

The first portion of the test consisted of statements designed to measure student attitudes towards science. There were three sections entitled *School Science*, *Science in Society*, and *Careers in Science*. In the *School Science* section, there were statements like "Science classes are boring" and "I like to study science in school." To respond to these statements, students would have five options to choose from, ranging from strongly disagree to strongly agree. In the *Science in Society* section, statements like "Science is important in our lives" and Science exists for the benefit of mankind" were posed to the students. In the *Careers in Science* section, students responded to statements like "Scientific work does not interest me" and "I would be satisfied spending my life as a scientist."

The three tests administered to students consisted of 120 multiple-choice questions. The questions were divided up into specific domains and objectives, and every student, no matter what test they were randomly given, answered the same number of questions from each area. The domain and objectives, along with the number of questions, can be seen below:

Category	**# Of Items**
Domain 1 – Processes and Skills	30
Domain 2 – Knowledge:Recall and Understand Objective 2.1 – Physical Sciences Objective 2.2 – Life Sciences Objective 2.3 – Earth/Space Sciences	30 (12) (12) (6)
Domain 3 – Application of Science Concepts Objective 3.1 – Physical Sciences Objective 3.2 – Life Sciences Objective 3.3 – Earth/Space Sciences	30 (12) (12) (6)
Domain 4 – Rational and Critical Thinking	15
Domain 5 – The Nature of Science	12
Domain 6 – Safety	12

For this study, Bateson divided the students up in to three strata; students in the first semester of the 4x4, students in the second semester of the 4x4 and students in a full-year schedule. In other words, the data was divided up into students in the 10th grade who had taken science in the first half of the year (approximately September to January – 4x4), students who had taken science in the second half of the year (approximately January to June – 4x4) and students who taken science for the whole year (year long – approximately August to June). The distribution of students, randomly given one of three tests, can be seen below:

	1ST SEMESTER	2ND SEMESTER	FULL-YEAR	TOTAL
TEST 1	1735	1173	6431	9339
TEST 2	1809	1224	6263	9296
TEST 3	1733	1199	6501	9433
TOTAL	5277	3596	19195	28068

After dividing the students into different class timetables, Bateson found the following mean scores:

Category	1st Semester	2nd Semester	Full-year
Domain 1 – Processes and Skills	47.3	49.1	51.2
Domain 2 – Knowledge: Recall and Understand	49.0	50.2	52.6
Objective 2.1 – Physical Science	45.8	47.9	49.6
Objective 2.2 – Life Sciences	51.9	52.7	56.4
Objective 2.3 – Earth/Space Sciences	49.5	49.8	52.8

Domain 3 – Application of Science Concepts Objective 3.1 – Physical Sciences Objective 3.2 – Life Sciences Objective 3.3 – Earth/Space Sciences	50.2 47.2 55.2 48.3	51.0 49.5 54.2 48.7	53.6 50.4 58.3 50.9
Domain 4 – Rational and Critical Thinking	46.5	46.6	50.3
Domain 5 – The Nature of Science	54.9	56.3	58.5
Domain 6 - Safety	72.3	74.7	76.5

To better understand the scores from the table, you have to understand how statistics plays a role in the data. Analysis of variance (ANOVA) procedures are used to consider items, examinee, and examinee by item interaction for each objective and domain. The ANOVA technique helps take away some of the uncertainty involved in the study. For example, the parent education level of examinees may indicate a propensity for higher scores. This value can not be accounted for in the study, even though it may be an important measure, because there was no question on the exam asking students what level of education their parents attained. Since a great deal of uncertainty exists, we say the mean scores fall over a range. For the scores in the table above, differences of 1-2% should be regarded as insignificant.

The results of the study found that all-year students scored significantly higher than either of the semester groups on every objective and domain of the assessment. In addition, the second semester students scored significantly higher than the first semester students on three of the six domains; Science Processes, Knowledge: Recall and Understand, and Safety. The differences on the other three domains were not significant, but the second semester did tend to score higher. This could be attributed to the fact that the tests were given in May to all students, from all the different scheduling timetables. The fact that second semester students consistently outperformed first semester students seems to indicate knowledge retention plays a role in test scores.

On the attitude and opinion statements, or affective scales, no significant differences were found among any of the groups. There was, however, a pattern that the full-year students scored slightly, but not significantly, higher than either of the semester groups on all scales.

2.3.3.4 The Gore Study.

One of the major studies to be done on block scheduling in recent years was Gordon Gore's, <u>Timetables and Academic Performance in the Sciences</u>. In this study, Gore analyzed the results of the 1996 British Columbia Provincial Exams.

In British Columbia the Provincial Exam counted as 40% of a student's course grade. The exams typically were given to 12^{th} grade students in English, Mathematics, Biology, Chemistry, Physics, French, History, Geography and Literature. The exams were taken immediately after classes end, no matter which timetable a student is on. The examination ran for two hours and consisted of half open-ended questions and half multiple choice.

With the results from the Provincial exams, Gore divided the data into three strata; schools with semester (4X4), quarter (Copernican), and full-year schedules. In his analysis, Gore found that students in schools on full-year timetables achieved higher marks that those on the semester or quarter schedule. In some subjects the difference was small, but the trend was consistent.

One of the major points that Gore tries to get across is that not only are the scores for the full-year timetables higher, but also the participation rates are higher. The Education Department in British Columbia defines the participation rate as the number of unique test takers divided by the September 30th grade 12 enrollment. In terms of this study, a high participation rate indicates that more students are taking the provincial exams from the "core courses" mentioned above. For example, as seen in the table below, 78% of the students in a full-year schedule who enrolled for English at the beginning of the year took the exam in English at the end of the year. Similarly, for English, 72.5% of the students in a semester schedule who enrolled for English at the beginning of the year took the exam in English at the end of the year. In English, 72.4% of the students in a quarter schedule (Copernican) who enrolled for English at the beginning of the year took the exam in English at the end of the year.

The participation rate has an effect on scores, because if only a small number of the brightest students enroll in a given course, the mean score on the final exam in that class would be higher. With the participation rates being highest for full-year timetables, there is further evidence in support of the higher scores for the full-year schedules.

The following is a table of the courses, scores, participation rates, and in some cases the number of students taking the exam from the full-year, semester, and quarter systems. The most successful scores are in bold. Differences in mean score of 1-2% should not be regarded as educationally significant.

MATHEMATICS	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	7951	9320	1112
MEAN SCORE	**69.41%**	64.63%	62.85%
PARTICIPATION RATE	**51.8%**	33.5%	27.4%

PHYSICS	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	2954	3058	310
MEAN SCORE	**69.38%**	68.45%	68.54%
PARTICIPATION RATE	**20.6%**	12.2%	8.6%

CHEMISTRY	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	4855	5700	592
MEAN SCORE	**71.54%**	70.15%	70.35%
PARTICIPATION RATE	**33.5%**	22.7%	16.2%

BIOLOGY	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	4398	6899	1072
MEAN SCORE	**69.32%**	67.63%	68.03%
PARTICIPATION RATE	**31.3%**	28.4%	29.4%

ENGLISH	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	NA	NA	NA
MEAN SCORE	**68.2%**	67.1%	65.2%
PARTICIPATION RATE	**78%**	72.5%	72.4%

FRENCH	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	NA	NA	NA
MEAN SCORE	**72.4%**	71.5%	70.9%
PARTICIPATION RATE	**20%**	11%	8%

HISTORY	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	NA	NA	NA
MEAN SCORE	**67.8%**	65.7%	65.1%
PARTICIPATION RATE	**21%**	17%	16%

GEOGRAPHY	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	NA	NA	NA
MEAN SCORE	**65.9%**	65.5%	63.6%
PARTICIPATION RATE	**24.5%**	19%	18%

LITERATURE	FULL-YEAR	SEMESTER	QUARTER
# OF STUDENTS	NA	NA	NA
MEAN SCORE	**71.9%**	69.8%	68.5%
PARTICIPATION RATE	**11%**	8%	8%

2.3.4 The IQP and the Five Studies

The focus of our IQP is to compare block scheduling and traditional scheduling by looking at test scores (SAT) and surveys (Leicester High School). The four Canadian studies and the North Carolina Report also examine surveys and tests scores. In the Canadian studies, the results from the analysis of exam scores indicates that the traditional schedule is the better scheduling alternative. The findings from the North Carolina Report show no difference between blocked and non blocked schools in terms of test scores.

Our study of block scheduling is most comparable to the North Carolina Report. In the North Carolina Report, four consecutive years of data (1993-1996) was used to make comparisons and draw conclusions about the effects of block scheduling. The Canadian studies are only focused on one year of a particular exam. In this IQP, SAT data for the years 1995-1998 will be analyzed within each school and compared with other schools.

2.3.5 Relevant IQP's

In Curriculum Development for High School Math and Science, Edward J. Domit and Harry Malkasian looked at ways to assist teaching professionals in making mathematics and science education a more meaningful and interesting experience for students. In our study of block scheduling, student opinions play a role in determining what schedule should be recommended. In the Leicester High School survey, one of the questions asks the students whether they have difficulty paying attention for 90 minutes.

In the IQP mentioned here, part of the goal is to make class go by quicker and not "drag on." The project looked at ways to improve teaching techniques and how the different topics should be presented. However, the multimedia aspect of learning is not explored as a solution. In the block scheduling format, computers, televisions, and videocassette recorders are being used to aid in learning.

2.4 Useful Techniques Needed to Accomplish the Project.

2.4.1 Data Collection

A significant amount of work in the early stages of this report involved data collection. This data was essential in our attempt to analyze and draw conclusions on the various scheduling systems. The majority of this data was collected from surveys and archived information containing SAT scores. The analysis and interpretation of this data then formed the core of this study.

2.4.1.1 Statistical Data

Acquiring quality statistical data was of utmost importance to this study. Most of this statistical data was composed of the calculated average SAT scores for most of the towns in the Province of Massachusetts. The source of much of this data originated from the Massachusetts Department of Education, while the rest came from archived information from various regional publications. Through the use of statistical analysis software, we hoped to analyze this data in attempt to evaluate the academic performance of various scheduling systems.

2.4.1.2 Surveys

Being able to conduct a successful survey was of great importance to this study. If a large return rate is expected, than it is necessary to create a survey in such a manner that makes it quick and easy to complete. To do this, the surveys had to be clear and concise. This was hoped to be accomplished through a few clearly worded multiple-choice questions that weren't too long as to lose the participants' interest. The questions on the survey should be of a close ended nature and any of the longer open ended questions should clearly be stated as "optional". This should make the survey look easy to complete without requiring too much of the participant's time.

Other factors to consider when constructing a survey are to make the questions as non-biased as possible. To have an accurate survey, the questions were worded in such a manner as to not influence the response of the test subjects. A survey that influences the results of a test sample does not measure the population accurately. This makes it important that no survey questions are unintentionally worded in a manner that would steer the participant towards a particular response. Therefore, a range of people examined the survey before being distributed to protect against the possible biasing of the questions.

2.4.2 Data Analysis and Interpretation

2.4.2.1 Statistical Analysis

A major portion of the project was to analyze the data from surveys and SAT scores by using statistical techniques and concepts. Statistics is the science of data: collecting data, analyzing data, and interpreting data. Histograms, frequency distributions, correlation between two or more items, averages, and variation were all used in the analysis of data. By using these statistical measures, more accurate conclusions were made as to the effects of block scheduling.

2.4.2.2 Cost/Benefit Analysis

One factor that was considered was the costs involved with a particular schedule. In cost/benefit analysis, the "worth" of any action equals the excess of the benefits it yields over the costs it entails. There were a number of questions that had to be answered when considering costs in a school system. Will more teachers have to be hired? Will the class offerings have to be expanded, paving the way for the need to buy more textbooks? Will multimedia items (computers, televisions, videocassette recorders, etc.) have to be purchased? A judgement will have to be made as to whether the benefits (benefits here are higher test scores and better student attitudes) outweighed the costs of implementing/keeping a particular schedule.

2.4.2.3 DECISIONS UNDER UNCERTAINTY

After analyzing the effects of block scheduling, recommendations were made to Leicester High School. If a change in schedule is suggested, it is important to consider how students and faculty will react. When a new schedule is implemented, a year or two is needed for faculty, as well as students, to adjust to the new timetable. Teaching styles often have to be modified to better work within the scheduling system. Students also must adjust to spending more/less time in a class.

If the schedule that is in existence now is still desired, there is obviously less risk. After looking at all the risks involved, a more accurate determination can be made for the type of scheduling system to be used.

3. Methodology

3.1 Data

3.1.1 SAT

For this project, a standardized test was needed to judge academic performance. The most widely used and most widely available is the Scholastic Aptitude Test (SAT). The SAT is an assessment of students mathematical and verbal skills. Students planning on attending a four-year college often have to take the SAT for admittance. The College Board, which administers the SAT, contends that the test is a good predictor for student performance in college. Since our study only included scores from the SAT, those students not taking the SAT were excluded. One of the only other alternatives was the MCAS test given to Massachusetts tenth graders. Unfortunately, the test was first administered in 1998, so there was only one year of data. In order to draw accurate conclusions about the effect of block scheduling, data over a number of years was needed. With data over a four-year period (1995-1999), it allowed for a comparison between performance and scheduling system.

3.1.2 Survey Population

The survey on block scheduling was given to both Leicester High School students and its faculty. The principal of Leicester High School was concerned with block scheduling and its effects on student learning, attitudes, and achievement test scores. There are some question as to whether a different type of block schedule should be implemented or possibly even revert back to a traditional schedule. Since the project is focused on Leicester High School's scheduling concerns, it was beneficial to survey both the students and the faculty there.

3.1.3 Test Population

Massachusetts SAT scores were chosen to compare the various scheduling systems across the state. High schools in Massachusetts are required to have 990 hours of structured learning time for the academic year. The hour requirements differ from state to state. Since this project was concerned with Leicester High School, it would make sense to look at schedules that work under the same time constraints.

3.2 Data Gathering Means

3.2.1 Surveys

Part of the analysis of block scheduling involved looking at surveys given to Leicester High School students. Student opinions help reflect how well the schedule is performing. However, it is important to consider that student opinions can be biased. The bias lies in the students attitude toward school.

One of the major points to consider when conducting a survey is the percentage of surveys that will be completed and returned. Since the surveys were given out during class, a 100% response rate is guaranteed. As a result of this, the survey data came from over 350 students at Leicester High School.

3.2.2 SAT Data

One portion of the study involved looking at the Scholastic Aptitude Test (SAT) and seeing if there was a correlation between scheduling and test scores. The hope was to look at the results of over 200 schools in Massachusetts. SAT data was obtained from the Massachusetts Department of Education for 1995 and 1998. Scores for 1996 were obtained from archived articles from The Boston Globe. For 1997, data was found from a back issue of Boston Magazine and various webpages.

3.2.3 Surveys for Schools

In order to analyze SAT scores, the scheduling system for each of the high schools is needed. It is necessary to know when block scheduling came into existence for these schools. To get this information, a written survey was sent through the mail to each of these high schools.

When dealing with letterform surveys, response times of over a month can be expected. Since the surveys were sent out in May, and they would not be needed for analysis until September, the time lag would not be a problem.

To increase the response rate and turnaround time, a clear and concise survey was needed. The survey included an explanation of what the study is about and how it is of benefit to all schools in Massachusetts. The survey consisted of three questions. Two of the questions are close-ended and multiple choice, while the other is optional and open ended. The first question asked the school which schedule most closely resembles their own. There is a choice of 4X4, 4X4 AB, Copernican and San Francisco Urban. The second question asked the school what year the schedule they are currently using came into existence. The choices include the years from 1993-1998 and an option of "other" (before 1993). The year 1993 is significant, because this is the time the Massachusetts Reform Act became law. The last question was optional and asks the schools what their opinion is of the schedule they are currently using. It was clearly explained that this question is optional and that it was most beneficial for the study if the first two questions are answered.

To encourage responses, a self-addressed stamped envelope was included in the letter to each school. Since the survey will take no longer than five minutes to fill out, a high response rate was expected. However, you can not expect 100 % of the surveys to be returned. Therefore, there was a second wave of surveys for schools that failed to reply to the original questionnaire. A second written survey as well as surveys via electronic mail was employed.

4 Analysis

4.1 Student Surveys

4.1.1 Introduction

The block scheduling survey was administered on October 5, 1999 to 442 students at Leicester High School. The responses broken down by grade were: 116 for grade 9, 129 for grade 10, 101 for grade 11, and 96 for grade 12. The surveys were anonymous for confidentiality reasons. By conducting an anonymous survey, it allows the students to voice their truthful opinions.

The purpose of the survey was to look at student opinions towards block scheduling. From the responses to the questions, we hope to infer things about block scheduling and evaluate its effectiveness, while identifying problems associated with it.

4.1.2 Survey Questions

Question #1: "Do you have difficulty concentrating for 90 minute class period?"

One of the problems related to block scheduling is the longer blocks. Some people have suggested that a 90-minute block is too long to keep a student's attention. However, proponents of block scheduling say the way the 90-minute block is structured can help hold the student's attention. A class broken down into many components like hands-on-projects, discussion, and lecture will captivate a student's interest more effectively than 90 minutes of straight lecture.

The responses for the first question may vary from grade to grade due to past experiences. A 9th grader, who has just finished middle school on a traditional schedule, might have a tough time concentrating for a 90-minute block. Conversely, a 12th grader, who has been on block scheduling for three years, will be more adjusted to 90 minute blocks.

Question #2: "Are you allowed time at the end of class to begin homework, talk, or study?"

The purpose of this question was to see if class time was being used effectively. The question can indicate whether a teacher has difficulty teaching in a block scheduling format. A teacher who has not adjusted to block scheduling may have trouble structuring their class to extend the full 90 minutes.

Question #3: "Do you have difficulty making up work after absences?"

Since one day in a block schedule is approximately equal to two days in a traditional schedule, there is concern that it may be difficult to make up work after absences.

Question #4: "Do you feel enough electives are offered?"

With block scheduling, students take 8 classes during the year as opposed to 7 for the traditional schedule. The additional block is usually filled by taking an elective course (outside of the core courses of math, science, English, foreign language and history). Leicester High School wants to determine whether or not there are enough options for elective classes to fill the additional block.

Question #5: "What is the average amount of homework you are assigned each night?"

The student could choose from A) Under 1 hour B) 1-2 hours and C) Over two hours. The purpose of this question was to compare the amount of homework received in a block schedule and a traditional schedule. Leicester High School also wanted to know if enough hours of homework were being assigned each night.

Question #6: "Number 1,2 or 3 the teaching styles most frequently used in your classes: 1's being most frequently used, 3's being least frequently used.

	Lecture	Audio-Visual	Group work	Technology	Discussion	Hands–on Projects
Art						
English						
Music						
Health						
Social Studies						
Foreign Language						
Math						
Technology						
Science						

The sixth question tried to determine what type of teaching styles were being employed in the new scheduling system. With the 90-minute block, teachers must modify their existing teaching styles to hold the student's attention.

Question #7: "Is the use of video in your classes Appropriate or too Frequent?"

There is concern that teachers might use video as a crutch to teach in the block-scheduling format. The way the question was worded, with answers only of Appropriate or Too frequent and excluding Not Enough, would indicate that Leicester High School is worried about the overuse of video in the classroom.

Question #8: "Do you find progression in classes such as foreign language and math difficult because of the gap between classes?"

In classes like math and foreign language, where new material is based on understanding and remembering previous concepts, the gap between successive classes can play a major role. For a class like history, the gap does not have as big an effect because the classes are usually independent of one another. For example, it is not necessary to remember all the concepts from American History to take an Ancient Western History course, but it is very important to remember concepts from Pre-Calculus class to take a course in Calculus. For this question, there were no responses from the 9th grade because they have only been on block scheduling for two months at the time this survey was administered.

Question #9: "Do all classes need to be 90 minutes daily?"

A number of courses work better in a 90-minute block than a 45-minute block. For example, science classes in a 90 minute block allow for longer lab periods, and as a result more hands-on learning. However, in a history class, where lecture is the predominantly used teaching style, a 45-minute block is ideal. The survey question tries to determine whether students think 90 minutes is too long for some classes.

Question #10: "If you could make one adjustment to block scheduling, what would it be?"

The tenth question asks the students to write down one adjustment that they would make to block scheduling.

Question #11: "Would you be willing to extend the day up to 6 minutes to allow for assemblies, class activities, etc.?"

With the advent of the Massachusetts Education Reform Act, public schools must spend a minimum number of hours (990) in structured learning time. Since the schedule in place now at Leicester high School barely conforms to the minimum requirements, there is not enough time in the school day to allow for assemblies and class activities. The answers to this question reflect how students feel about school. If the students were willing to spend more time at school, the assumption could be made that they have a positive attitude towards school.

Question #12: "Does it matter to you if there is any change in the current block schedule?"

The question tries to determine if students are satisfied or dissatisfied with block scheduling.

Question #13: "Circle three from the following list of statements that you feel best describe the positive things about block scheduling at Leicester High School:"

Classes only last ½ year	Fewer classes to handle at one time
More variety in the classroom	Quiet school atmosphere
More in-depth study	Ability to take more classes (8 each year)
Increased science lab time	

One of the drawbacks of block scheduling is not as much material is covered as compared to a traditional schedule. However, in theory, the material should be covered in greater detail and depth than in a traditional schedule. Ideally, in the block schedule, the material that is taught by lecture will be backed up with hands-on projects, discussion, technology, etc. This is what is meant in the above list as "In-depth study." "A quiet school atmosphere" is the result of less passing time during the course of the day due to fewer classes. The other choices for question #13 are self-explanatory.

*** Transfer Students (For students who have transferred into Leicester High School from another school) ***

<u>Question #1A: "Did you find the adjustment to the block schedule difficult?"</u>

<u>Question #2A: "If you transferred from a school with a more traditional 6 or 7 period day, which of the two schedules do you prefer?"</u>

4.1.3 Initial Observations

Question #6 was not analyzed due to the fact that the students didn't answer it properly.

<u>Grade 9 survey totals</u>

Question #	Yes	No	Not Answered
1	67	49	0
3	66	44	6
4	44	71	1
8	-	-	-
9	25	88	3
11	72	44	0
12	59	56	1

Transfer Student Question	No	Yes
#1 A	10	4

Transfer Student Question	Block	Traditional
#2 A	9	4

Question #2	Always	Sometimes	Never	Not answered
	4	107	5	0

Question #5	Under 1 hour	1-2 hours	Over 2 hours	Not answered
	18	80	18	0

Question #7	Appropriate	Too frequent	Not answered
	107	8	1

Question #10	Most Common Answers
7-45 minute periods	33
More time to change classes	17
Break in the middle of class	13
Study period	13
5-60 minute periods	3
2-90 + 4-45 minute periods	2

Question #13	
Classes only last ½ year	85
Fewer classes to handle	106
Increased science lab time	18
More in-depth study	38
More variety in the classroom	36
Quiet school atmosphere	24
Ability to take more classes	31

Grade 10 survey totals

Question #	Yes	No	Not Answered
1	63	60	6
3	56	69	4
4	57	71	1
8	44	82	3
9	38	89	2
11	66	62	1
12	68	59	2

Transfer Student Question	No	Yes
#1 A	15	4

Transfer Student Question	Block	Traditional
#2 A	16	2

Question #2	Always	Sometimes	Never	Not answered
	3	119	7	0

Question #5	Under 1 hour	1-2 hours	Over 2 hours	Not answered
	22	69	38	0

Question #7	Appropriate	Too frequent	Not answered
	125	1	3

Question #10	
Shorter classes	32
Study period	27
More time to change classes	20
Break in the middle of class	14
Keep the same schedule	14
More electives	3

Question #13	
Classes only last ½ year	106
Fewer classes to handle	107
Increased science lab time	37
More in-depth study	31
More variety in the classroom	38
Quiet school atmosphere	17
Ability to take more classes	35

<u>Grade 11 survey totals</u>

Question #	Yes	No	Not Answered
1	48	48	5
3	49	52	0
4	28	72	1
8	46	47	8
9	23	74	4
11	48	51	2
12	60	38	3

Transfer Student Question	No	Yes
#1 A	16	4

Transfer Student Question	Block	Traditional
#2 A	13	5

Question #2	Always	Sometimes	Never	Not answered
	5	90	6	0

Question #5	Under 1 hour	1-2 hours	Over 2 hours	Not answered
	16	74	11	0

Question #7	Appropriate	Too frequent	Not answered
	93	3	5

Question #10	
Break in the middle of class	21
Study period	20
5-60 minute blocks	16
More time to change classes	12
Make some classes a year long	4

Question #13	
Classes only last ½ year	73
Fewer classes to handle	89
Increased science lab time	20
More in-depth study	31
More variety in the classroom	18
Quiet school atmosphere	10
Ability to take more classes	27

Grade 12 survey totals

Question #	Yes	No	Not Answered
1	55	38	3
3	42	53	1
4	27	67	2
8	45	49	2
9	24	68	2
11	59	36	1
12	34	61	1

Transfer Student Question	No	Yes
#1 A	9	8

Transfer Student Question	Block	Traditional
#2 A	6	10

Question #2	Always	Sometimes	Never	Not answered
	0	86	9	1

Question #5	Under 1 hour	1-2 hours	Over 2 hours	Not answered
	22	52	21	1

Question #7	Appropriate	Too frequent	Not answered
	82	2	12

Question #10	
Study period	20
More time to change classes	13
Break in the middle of class	13
More electives	10
Shorter lectures	9

Question #13	
Classes only last ½ year	71
Fewer classes to handle	81
Increased science lab time	17
More in-depth study	30
More variety in the classroom	14
Quiet school atmosphere	4
Ability to take more classes	29

4.1.4 Statistical Significance

The analysis of student surveys involved trying to determine whether there was a statistically significant difference between yes and no responses. A hypothesis test was used, with data from a binomial distribution, to determine the statistical significance between yes and no answers.

A hypothesis test consists of five components: the scientific hypothesis, the statistical model, the statistical hypothesis, the test statistic, and the p-value.

The scientific hypothesis is the hypothesized outcome of the experiment. The goal of the study is to see if there is evidence for the scientific hypothesis. In our study, the scientific hypothesis is that there is a difference between yes and no responses. We want to find out how strong the evidence is in favor of $p \neq .5$.

The statistical model is used to describe the observed data. The model depends on the design of the experiment, or how the data is obtained. For our study, the data follows a binomial distribution. The binomial distribution is defined in terms of the binomial trial. A binomial trial is a data-gathering scheme that must satisfy two conditions. In a binomial trial, the probability of success must be the same value, p, for each of the n trials. In our study, $p = .5$ for each of the trials because each student has a choice of two responses – yes or no. The number of trials varies, depending on the grade. The second rule is that the binomial trial must consist of n independent trials. Independent means that each trial is run exactly the same way regardless of what happens on other trials. In our study, the surveys were given to the students at the same time so there could not be an influence from past trials. The data could also not be affected by other trials, because each trial (survey) was administered to each student independently. The binomial distribution model is expressed as $Y \sim b(n, p)$, where Y represents an observation from a $b(n, p)$ distribution. As mentioned above, n is the number of trials and p is the probability of success.

The statistical hypothesis consists of two hypotheses: the null hypothesis and the alternate hypothesis. The alternate hypothesis corresponds to the scientific hypothesis and the null hypothesis contradicts the scientific hypothesis. In our study, the null hypothesis is $p = .5$. The two hypotheses can be written more concisely as:

H_o: $p = .5$

H_a: $p \neq .5$

The test statistic is a measurement that provides evidence to decide between the null and alternate hypothesis. In our study, the test statistic is the number of people who responded yes/no to each of the questions.

Our study begins with assuming that H_o is true, or p = .5. Under this assumption, the test statistic (number of yes/no responses) follows a known distribution model (binomial). The p-value quantifies how consistent the observed value of the test statistic is with this distribution model, and hence with H_o. Therefore, the p-value is the proportion of the values from the distribution model which gives as much or more evidence against H_o and in favor of H_a as does the observed value of the test statistic. The smaller the p-value, the greater the evidence in support of the alternate hypothesis, H_a. The following chart can be used to interpret p-values:

IF THE P-VALUE IS :	THE EVIDENCE AGAINST H_O AND IN FAVOR OF H_A IS:
>.1	NOT SIGNIFICANT
<.1	BORDERLINE SIGNIFICANCE
<.05	REASONABLY STRONG SIGNIFICANCE
<.025	STRONG SIGNIFICANCE
<.01	VERY STRONG SIGNIFICANCE

For our analysis, it was necessary to normalize n, the number of trials, to 100. The only binomial chart available with n large was n = 50 and n = 100. To normalize a yes/no response, the following steps must be taken:

1. Find the total number of trials

2. Divide the number of trials by 100.

3. Divide the number of yes/no responses by answer found in part 2.

For example, in grade 9 Question #1, with answers of yes = 67 and no = 49, the responses would be normalized by the following steps:

1. 67 + 49 = 116 (number of trials, n)

2. 116 / 100 = 1.16

3. Normalized yes = 67 / 1.16 = 57.75 = 58

   Normalized no = 49 / 1.16 = 42.24 = 42

As can be seen on the charts, there is a column entitled "Other." The numbers in this column correspond to those students who left the answer blank or wrote in their own answer. The values for "Other" were not used in our analysis.

Question #7 is not a yes/no question per say, but still follows a binomial distribution model. Instead of yes/no responses, the student could choose from Appropriate/Too Frequent. Obviously, for this question, the same analysis will be done for statistical significance.

Statistical Significance results for questions with two possible responses:

Data Table for Grade 9

Question #	Yes	No	Other	Normalized "Yes"	Normalized "No"	P-value	Conclusion
1	67	49	0	58	42	.06661	Reasonably Strong significance
3	66	44	6	60	40	.028440	Strong significance
4	44	71	1	38	62	.010490	Strong significance
8	--	--	--	--	--	--	--
9	25	88	3	22	78	<.00001	Very Strong significance
11	72	44	1	62	38	.01049	Very Strong significance
12	59	56	2	51	49	.46021	Not significant

Question #	Appropriate	Too Frequent	Other	Normalized "Appropriate"	Normalized "Too Frequent"	P-value	Conclusion
7	107	8	1	93	7	<.00001	Very Strong Significance

For Grade 9, the responses show a reasonably strong level of significance for students having difficulty concentrating for 90-minute class period.

There was a strong significant difference in student responses to whether or not they have difficulty making up work after absences and whether they feel enough electives are offered. The majority of students in Grade 9 felt that it is difficult to make up work after absences and that not enough electives are offered.

There was also a very strong significant difference in their responses to whether or not they would be willing to extend the school day up to 6 minutes for assemblies and class activities, whether classes had to be 90 minutes daily, and if the use of video was appropriate or too frequent. The majority of students in Grade 9 felt that all classes do not need to be 90 minutes daily and they also were in favor of extending the school day up to 6 minutes. The students felt that the use of video was appropriate in the classroom

Data Table for grade 10.

Question #	Yes	No	Other	Normalized "Yes"	Normalized "No"	P_Value	Conclusion
1	63	60	6	49	47	.20865	Not significant
3	56	69	4	43	53	.0961	Borderline significant
4	57	71	1	44	55	.13563	Not significant
8	44	82	3	29	64	.00002	Very strong significance
9	38	89	2	29	69	.00002	Very strong significance
11	66	62	1	51	48	.38218	Not significant
12	68	59	2	53	46	.242	Not significant

Question #	Appropriate	Too Frequent	Other	Normalized "Appropriate"	Normalized "Too Frequent"	P-value	Conclusion
7	125	1	3	97	1	<.00001	Very strong significance

For grade 10, the responses show that for question #3 that there is only a borderline level of significance for not having difficulty in making up work after absences.

There was also a very strong significant response to question #7, #8, and #9. These results show that in grade 10 that the majority of students felt that there was no difficulty in the progression of classes and they didn't think all classes needed to be 90 minutes daily. The results from #7 shows that they feel that an adequate amount of video is being used in the classroom.

Data Table for Grade 11

Question #	Yes	No	Other	Normalized "Yes"	Normalized "No"	P-value	Conclusion
1	48	48	5	50	50	.53979	Not significant
3	49	52	1	49	51	.46021	Not significant
4	28	72	1	28	72	.00001	Very strong significance
8	46	47	8	49	51	.46021	Not significant
9	23	74	4	24	76	.00056	Very strong significance
11	48	51	2	48	52	.38218	Not significant
12	60	38	3	61	39	.01760	Very strong significance

Question #	Appropriate	Too Frequent	Other	Normalized "Appropriate"	Normalized "Too Frequent"	P-value	Conclusion
7	93	3	3	97	3	<.00001	Very strong significance

There was a very strong significant difference in student responses to whether or not they feel enough electives are offered, whether all classes need to be 90 minutes daily, if it matters if there is any change in the current block schedule and if the use of video was appropriate or too frequent. The majority of students in Grade 11 felt that not enough electives are offered, not all classes need to be 90 minutes daily, it does matter if there is any change in the current block schedule, and the use of video is appropriate in the classroom.

Data Table for grade 12.

Question #	Yes	No	other	Normalized "Yes"	Normalized "No"	P_Value	Conclusion
1	55	38	3	57	40	.02894	Reasonably strong significance
3	42	53	1	44	55	.13563	Not significant
4	27	67	2	28	70	.00001	Very strong significance
7	82	2	12	85	2	<.00001	Very strong significance
8	45	49	2	47	51	.30865	Not significant
9	24	68	2	25	71	< .00001	Very strong significance
11	59	36	1	61	38	.01049	Strong significance
12	34	61	1	35	64	.00176	Very strong significance

Question #	Appropriate	Too Frequent	Other	Normalized "Appropriate"	Normalized "Too Frequent"	P-value	Conclusion
7	82	2	12	85	2	<.00001	Very strong significance

In grade 12, the survey showed a reasonably strong level of significance for students having difficulty concentrating for 90 minute periods, in question #1.

In question 4, a large portion of the students demonstrated with very strong response that they didn't feel that enough electives were offered. Students demonstrated in question #9 that they also didn't believe that all classes should be 90 minutes daily. There is also a very strong statistical significance in question #7 for students feeling that an adequate amount of video is being used in the classroom. Question #12 also showed strong significance for students feeling it didn't matter to them if the current block scheduling system was changed.

From Question # 11 we see there was also a significantly large number of students that felt they wouldn't mind extending the school day by 6 minutes.

The procedure explained above applies to questions with two responses. However, two of the questions on the student survey (Q #2 + Q #5) contain three possible answers. To analyze these questions, a Pearson's χ^2 test must be used. Below is an outline of the Pearson's χ^2 hypothesis test:

The Scientific Hypothesis: The hypothesized outcome of the experiment. The goal of the study is to see if there is evidence for the scientific hypothesis.

The Statistical Model: The population is divided into c categories with proportion p_i in category i.

The Statistical Hypothesis:

H_o: $p_i = p_i^{(0)}$, $i = 1,2,,\ldots,c$

H_a: $p_i \neq p_i^{(0)}$, for at least one i, i=1,2,…,c

For pre-specified values $p_i^{(0)}$, $i = 1,2,,\ldots,c$

The Test Statistic: $\chi^2 = \Sigma^c{}_{i=1} (Y_i - np_i^{(0)})^2 / np_i^{(0)}$

Where n is the total number of responses and Y_i is a particular response.

Large values of χ^2 indicate a difference between the expected and observed number in at least one of the three categories, and therefore, provide evidence against H_o and in favor of H_a.

The p – Value: $P (Y \geq \chi^{2*})$, where $Y \sim \chi^2_{c-1}$ and χ^{2*} is the observed value of the test statistic.

The following is an example to help better understand the concepts and formulas outlined above:

For Grade 10 on the student surveys, Question #5 asks the students what the average amount of hours they spend per night on homework. The answers broke down into the following:

Question #5	Under 1 hour	1-2 hours	Over 2 hours
	22	52	21

The Scientific Hypothesis: In this problem, the scientific hypothesis is that there is a difference between three responses. We want to find out how strong the evidence is in favor of $p_i \neq .33$.

The Statistical Model: For our problem, with three responses, the population would be divided into three categories with proportion .33 for each i.

The Statistical Hypothesis:

H_o: $p_i = .33$, $i = 1,2,3$

H_a: $p_i \neq .33$ for at least one i, i=1,2,3

The Test Statistic: First we have to find the cell frequency, or $np_i^{(0)}$ in the test statistic equation ($\chi^2 = \Sigma^c_{i=1} (Y_i - np_i^{(0)})^2 / np_i^{(0)}$). Under H_o, each cell frequency is (total number of responses to Question #5) * (probability). This is 95(n) * .33($p_i^{(0)}$) = 31.35. So,

$\chi^2 = (22\text{-}31.35)^2/31.35 + (52\text{-}31.35)^2/31.35 + (21\text{-}31.35)^2/31.35 =$

2.789 + 13.602 +3.417=

19.808

Now, to find the p-value, a table of the Critical Values of the χ^2 Distribution must be used. The k value is equal to n-1, or 2 in this example. You then look across at the value closest to the χ^2 found (19.808 in this example) and find the p-value. For χ^2 = 19.808, the chart only goes up to χ^2 = 10.60 with p-value = .005, so we can conclude that the p-value is less than .005. This gives very strong significant proof for H_a: $p_i \neq .33$.

The following is a table to better interpret p-values:

IF THE P-VALUE IS :	THE EVIDENCE AGAINST H_O AND IN FAVOR OF H_A IS:
>.1	NOT SIGNIFICANT
<.1	BORDERLINE SIGNIFICANCE
<.05	REASONABLY STRONG SIGNIFICANCE
<.025	STRONG SIGNIFICANCE
<.01	VERY STRONG SIGNIFICANCE

Statistical Significance results for questions with three possible responses:

Grade 9 Data Table

	Always	Never	Sometimes	X^{2*}	P -value	Significance
Q #2	4	5	107	182.9	<.005	Very strong

	Under 1 Hour	1-2 Hours	Over 2 Hours	X^{2*}	P - value	Significance
Q #5	18	80	18	66.95	<.005	Very strong

Grade 10 Data Table

	Always	Never	Sometimes	X^{2*}	P -value	Significance
Q #2	3	7	119	203.7	<.005	Very strong

	Under 1 Hour	1-2 Hours	Over 2 Hours	X^{2*}	P -value	Significance
Q #5	22	69	38	26.84	<.005	Very strong

Grade 11 Data Table

	Always	Never	Sometimes	X^{2*}	P -value	Significance
Q #2	5	6	90	141.3	<.005	Very strong

	Under 1 Hour	1-2 Hours	Over 2 Hours	X^{2*}	P -value	Significance
Q #5	16	74	11	72.85	<.005	Very strong

Grade 12 Data Table

	Always	Never	Sometimes	X^{2*}	P -value	Significance
Q #2	0	9	86	142.5	<.005	Very strong

	Under 1 Hour	1-2 Hours	Over 2 Hours	X^{2*}	P -value	Significance
Q #5	22	52	21	19.81	<.005	Very strong

4.1.5 Agreement Analysis on the Student Survey

While analyzing the student surveys, a noticeable pattern started to emerge from the results. The pattern that appeared was that if students answered one of the questions in a particular way their answer to some of the other questions could be predicted with what appeared to be a high rate of success. The results that were expected should have been of a more random nature. Since they followed a more predictable pattern than one would expect, an investigation to try to find out why was conducted.

After looking at the survey results, an attempt was made to see what relationship there may have been between some of the various questions that could have their response predicted. The questions that appeared to be related in such a way so that knowing the response of one of them could help predict the response of the others were question #1, 5, and 8. Question #1 asks the student "Do you have difficulty concentrating for a 90 minute class period?" Question #5 asks "What is the average amount of homework you are assigned each night?" Question #8 asks "Do you find progression in classes such as foreign language and math difficult because of the gap between classes?" What is interesting about these three questions is that they give insight into how well disciplined a student is academically. Considering this information, the question was posed whether block scheduling affects certain types of students more than others and if by knowing this information, is it possible to modify the schedule in order to increase the number of students that benefit from it.

Statistics was used to find out if the survey showed there were different types of students that would benefit or be hurt by the current scheduling system. Due to the occasionally over complicated nature of the statistical arts, only question #1 and #8 were analyzed in this study. Therefore, we are left with only the statistical means to see what type of relationship is there between question #1 on students concentrating for 90 minutes and question #8 regarding the difficulty in the gap between sequential classes that occur in a 4x4 system. Since the student survey was presented during the first half of the year, the freshman of Leicester High School were unable to accurately answer question #8. This means the analysis would be limited to grades 10, 11, and 12.

To perform the analysis, Kappa statistics were used. Kappa statistics measure the agree-ability between the responses. In other words, it tries to statistically test whether or not people who answer a question one way have a tendency to answer another question with the same response. The end result of this test provides us with a Kappa value and a confidence interval. The confidence interval is of the most use to us because it tells us with 95% confidence whether or not there is any agree-ability/ disagree-ability as opposed to the responses being random. We can tell whether or not there is any trend of agreement or disagreement with the confidence interval if the interval does not contain zero. We can also see that there is agreement as opposed to disagreement among the responses if the confidence interval is positive and not negative. An example of the results from using a Kappa statistics macro within a statistical analysis program can be seen below. Additional examples from our data set can be seen in appendix A-7.

Table of X by Y

X (down) / Y (across) Percent Row Percent Column Percent	No	Yes	Total
No	31 34.83 68.89 70.45	14 15.73 31.11 31.11	45 50.56
Yes	13 14.6 29.55 29.55	44 34.83 70.45 68.89	44 49.44
Total	44 49.44	45 50.56	89 100.00

Simple Kappa Coefficient

		95% Confidence Bounds
Kappa = 0.393	ASE = 0.097	(0.202 , 0.584)

The output above shows the table of results for the analysis of grade 11 on question #1 and #8. X represents question #1 while Y is question #8.

After conducting these tests on question #1 and #8 for grades 10 through 12, we can see that with 95% confidence there is strong agreement among the results. This shows that statistically speaking there is a large predictability factor that allows us to know the results of one answer if we know the results of the other. This shows us that there is definitely a trend where students who have difficulty concentrating for 90 minutes have difficulty with the gap between sequential courses. Looking at the Kappa statistics slightly differently also shows us that the students who have difficulty with the gap have a tendency to have trouble concentrating for 90 minutes. This may sound obvious and redundant but is necessary, for it is possible for both students that do and don't have trouble concentrating for 90 minutes to find the gap between sequential courses difficult. If that were so, it would not be possible to state that the students having difficulty with the course gap are also having difficulty concentrating for 90 minutes. Conversely, the Kappa statistics tells us that the students who have no problem concentrating for 90 minutes generally don't have trouble with the gap between sequential courses. It also tells us how students that don't have difficulty with the gap feel about concentrating for 90 minutes.

From the results of these Kappa statistics, conclusions can be drawn. There appears to be two distinct groups of students, one group that has difficulty with some of the aspects of the 4x4 scheduling system and the other group that doesn't. These two groups appear to be split about 50/50 among each grade, which tells us that those who have difficulty and those who have none with the schedule are neither a minority nor majority. Realizing that, this information could then serve as supporting evidence to the idea that a 4x4 block schedule is not in the best interest of all students. The 4x4 block schedule may be looked upon favorably by more academically disciplined students and less so by others.

4.1.6 Conclusions

The administration at Leicester High School should be concerned about the results of the student survey. The negatives often associated with block scheduling exist at the high school. Specifically, student attention spans, the time lag between classes, and making up work after absences are all factors that need to be addressed.

A majority of the faculty feel that students in academic level classes have trouble concentrating for 90 minutes. However, from the results of the student surveys, it appears the problem is more widespread than the faculty realize. Question #1 of the student survey asks the pupil : "Do you have difficulty concentrating for 90 minutes?" Out of the 428 students surveyed, 233 said they have difficulty concentrating for 90 minutes. This translates into 55% of the student body who lose focus during the 90 minute block. Since only 25% of the student body is on the academic track, we can make the assumption that the longer blocks are taking a toll on more than just the academic level track students.

The breakdown of the answers to Question #1 reveal a great deal about transition to a new schedule. For Grade 9, 67 students had difficulty with the 90 minute blocks, while 49 did not. Recalling from section 4.1.4, our study begins with assuming H_o is true, or $p = .50$. The p-value quantifies how consistent the observed value of the test statistic is with H_o. The smaller the p-value, the greater the evidence in support of the alternate hypothesis, or $p \neq .50$. The p-value for this question was .0666, which gave reasonably strong statistical evidence in favor of the alternate hypothesis ($p \neq .50$). This means there is reasonably strong statistical evidence that the responses were not equally distributed (p

$\neq .50$), and therefore, we can conclude that for the ninth grade, students had difficulty concentrating for 90 minutes. The reason for this could be that students are having difficulty adjusting to the block schedule. When the survey was administered in October, students in the 9^{th} grade had been on a block schedule for less than two months. In the 8^{th} grade, at the middle school, students take classes in a seven period traditional school day. The adjustment from taking 45 minute classes to taking 90 minute classes can be overwhelming to a 9^{th} grader. These students have to get used to being at a new school with new teachers and new classmates. To make the transition to a new schedule only compounds these difficulties. If the same survey was given today to the 9^{th} grade, you might expect the answers to Question #1 to even out. This can be predicted with confidence because of the results from the 10^{th} and 11^{th} grade. For the 10^{th} grade, 63 pupils replied yes, and 60 answered no. For the 11^{th} grade, the responses were also spread evenly, with 48 students replying yes and 48 responding no. From these results, we might say that it takes a certain period of time to adjust to the block schedule.

If the transition from the 8^{th} to the 9^{th} grade gives reason to explain the high percentage of people (55%) who have difficulty concentrating for 90 minutes, then the bias that lies in the question may act to negate this factor. Even though the surveys are anonymous, a student may not want to "admit to being stupid" by saying he/she can not concentrate for 90 minutes.

The transition from 8^{th} grade to 9^{th} grade is also reflected by the results of Question #3. Question #3 asks the student: "Do you have difficulty making up work after absences?" For Grade 9, 66 students had difficulty making up work after absences, while 44 did not. The p-value for this question was .02844, which gave strong statistical evidence in favor of the alternate hypothesis ($p \neq .50$). This means there is strong statistical evidence that the responses were not equally distributed ($p \neq .50$), and therefore, we can conclude that for the ninth grade, students had difficulty making up work after absences. However, when you look at the results from Grade 10, it appears that student opinions have taken a 180-degree turn. Only 56 students in the 10^{th} grade had difficulty making up work after absences, while 69 did not. The p-value for this question was .0961, which gave borderline statistical evidence in favor of the alternate hypothesis ($p \neq .50$). This means there is borderline statistical evidence that the responses were not equally distributed ($p \neq .50$), and therefore, we can conclude that for the 10^{th} grade, students did not have difficulty making up work after absences. For grade 11, the responses are split fairly evenly, 49 yes and 52 no. For the 12th grade, the responses behave similarly to Grade 11, with 42 students responding yes and 52 responding no.

Even though the data shows a positive trend, where students adjust to block scheduling over time, the administration should be concerned about the "big picture." Looking at the entire student population shows a glaring problem with block scheduling. Over 49% (213 out of 431) of the students at Leicester High School have trouble making up work after absences. The reason for this is when a student misses a class in a school using a 4x4 schedule, they can fall behind in a subject. Remember, that one class in a 4x4 schedule is roughly equivalent to two classes in a traditional schedule. If a student misses two straight days of class, this situation is further compounded.

Another problem often associated with block scheduling is the layoff in sequential subjects of up to a year. Question #8 asks the student if they find progression in classes such as foreign language and math difficult because of the gap between classes. For this question, there were no responses from the 9^{th} grade because they had only been on block scheduling for two months at the time this survey was administered. In Grade 10, 44 of the students felt progression in classes was difficult, while 82 had no problem with the layoff between classes. The p-value for this question was .00002, which gave very strong statistical evidence in favor of the alternate hypothesis ($p \neq .50$). This means there is very strong statistical evidence that the responses were not equally distributed ($p \neq .50$), and therefore, we can conclude that for the 10th grade, students did not have difficulty with the time lag between successive classes. The reason for this could be that many of the students in the 10t^{h} grade have not dealt with the time lag between classes. Students in the 10th grade have only been on the block schedule for a year and two months (at the time the survey was administered). Sophomore students would only have dealt with the time lag once – for successive classes that took place in the first semester of the freshman year followed by classes in the first semester of the sophomore year. Since the gap between courses mainly effects foreign language and math classes, the faculty should only be concerned about students who had these classes in the first semester of the freshman year followed by the successive class in the first semester of the sophomore year. The percentage of students in this population would not be very high. Students in the 10th grade also would not have dealt with the time lag of a year between successive classes. The first time this can occur is if a student has a class in the first semester of the freshman year, and does not have the next successive class until the second semester of the sophomore year. For these reasons, we can say that students in the 12th grade are more likely to say no than yes to question #8. For grades 11 and 12 the responses were split fairly evenly. For grade 11, 46 students responded yes, while 47 had no problem with the time lag. For Grade 12, 45 students responded yes to Question #8 and 49 replied no.

The fact that students had trouble with progression indicates that more time is needed for review. In classes like foreign language and math, where new material is based on understanding and remembering previous concepts, an even greater amount of time should be spent "going over the basics." If more time is spent on review, it would, in theory, ease the transition for students who have successive classes separated by a year. However, the major drawback with this plan is by spending more time on review, it is cutting into the time where new material should be taught. This would aid lack of coverage of new material, which is already a huge problem in the school system.

Leicester High School wanted to find out if class time was being used effectively. Question #2 asked the student: "Are you allowed time at the end of class to do homework, talk, or study?" The student could respond A) Always, B) Sometimes, or C) Never. For Grade 9, 107 students said that sometimes they are allowed free time, while 4 said always and 5 said they were never given extra time at the end of class. Recalling from section 4.1.4, our study begins with assuming H_o is true, or $p = .33$. The p-value quantifies how consistent the observed value of the test statistic is with H_o. The smaller the p-value, the greater the evidence in support of the alternate hypothesis, or $p \neq .33$. The p-value for this question was <.00005, which gave very strong statistical evidence in favor of the alternate hypothesis ($p \neq .33$). This means there is very strong statistical evidence that the responses were not equally distributed ($p \neq .33$), and therefore, we can conclude that sometimes students were allowed time to work on homework, talk, or study at the end of class. For Grades 10-12, the responses were very similar to grade 9, with very strong statistical evidence that the responses were not equally distributed ($p \neq .33$), Therefore, we can conclude that sometimes students were allowed time to work on homework, talk, or study at the end of class. The time students are allowed to do homework, talk, or study takes away from the time where new material should be covered. The faculty is allowing extra time at the end of class because they realize students are losing focus after a period of time. The fact that it only occurs "sometimes" should not be a concern to Leicester High School.

Question #7 also set out to determine how class time was being used. Question #7 asked: "Is the use of video in your classes appropriate or too frequent?" For Grade 9, 107 out of 115 student felt that the use of video was appropriate. For Grade 10-12, the responses were very similar to grade 9, with very strong statistical evidence that the responses were not equally distributed ($p \neq .50$), Therefore, we can conclude that the use of video is appropriate. From the answers, we can say with confidence that the faculty is not using video as a crutch to teach in the block schedule. The responses to the faculty survey and the two faculty related questions on the student survey show that the teachers have adjusted to the block schedule.

The Leicester High School faculty and students seem to agree on two issues outlined in the survey. The student and faculty feel that there are not enough electives offered and all classes do not need to be 90 minutes daily. Question #4 asks the student: "Do you feel enough electives are offered?" For Grade 9, 71 students felt that there should be more selection in elective offerings and 44 felt the number of elective classes was acceptable. The p-value for this question was .01049, which gave strong statistical evidence in favor of the alternate hypothesis ($p \neq .50$). This means there is strong statistical evidence that the responses were not equally distributed ($p \neq .50$), and therefore, we can conclude that for the 9^{th} grade, students felt that not enough electives are offered. Grades 10-12 also felt that there are not enough elective courses. The addition of an extra block, due to the fact that in a 4x4 schedule you have 8 classes and in a traditional schedule you have 7 classes, raised the need for more class offerings. If more teachers were hired, the problem would be solved. Unfortunately, schools run on a tight budget, and as a result hiring extra teachers may be out of the question.

The faculty and students also agree that 90 minutes is too long for some classes. Question #9 asked the student: "Do all classes need to be 90 minutes daily?" For Grade 9, 25 students felt that all classes should be 90 minutes long, while 88 felt that some classes should not be 90 minutes. The p-value for this question was .00001, which gave very strong statistical evidence in favor of the alternate hypothesis ($p \neq .50$). This means there is very strong statistical evidence that the responses were not equally $p \neq .50$), and therefore, we can conclude that for the 9th grade, students felt that not all classes have to be 90 minutes daily. For Grades 10-12, thew data supported the alternate hypothesis with the same level of significance as the 9th grade.

The faculty and administration should be concerned because the responses show that students have trouble concentrating for 90 minutes. This problem acts as the root of many other problems in the block schedule. As was noted in the faculty survey, less topics are covered in the block because students can not concentrate for 90 minutes. Students are sometimes allowed time at the end of class to unwind because they have been sitting for such a long time and the teacher feels the students are losing focus. The students want more time to change classes, a break in the middle of class, and shorter classes in general because 90 minutes is too long.

4.2 Faculty Surveys

4.2.1 Introduction

The block scheduling teacher survey was administered on May 13, 1999 to 24 member of the Leicester High School faculty. The survey was given to all teachers in the math, English, science, social studies, foreign language, guidance, library, physical education, health, music, art, and industrial departments. From the survey, we hope to infer things about how teachers feel about block scheduling and how it affects various departments. There is space available for the teachers to make comments, and we hope to see if there is any relationship between the department and the type of comments.

4.2.2 Survey Questions

Question #1: "Do you find it difficult to teach for 90 minutes?"

The question tries to determine if teachers have adjusted to block scheduling. With 90 minute blocks, it is necessary to vary teaching styles to keep the student's attention. The type of student in the class may also have an effect on whether or not it is difficult to teach for 90 minutes. It would probably be tougher to keep the interest of a student in the academic track than a student in the college/honors track (The academic track is designed for students who plan on going straight to work or to a community college after high school. The college/honors track is for those students who plan on attending a four-year college after high school.).

Question #2: "Do you find it hard to prepare sufficient work for your absences?"

Rarely, if ever, can a substitute come into a class and start where the teacher left off on the previous day. The substitute is usually there to watch over the students as they do "busy work." It may be difficult to assign work because there is a limit to how much "busy work" can be assigned before it becomes over whelming.

Question #3:"In comparison to the traditional seven period day, how much of the course syllabus are you able to cover under the current schedule?"

For this question, the teacher has the opportunity to choose from: A) Same Amount, B) More, or C) Less. The question arises from the fact that one day in a block schedule is approximately equal to two days in a traditional schedule. The general consensus is that it is very difficult to cover in one block scheduling period what would be covered in two traditional periods. The thinking is that it is too much material for a high school student to grasp. Most schools under the block have accepted this and are covering a lesser amount of material, but in greater depth.

Question #4: "Do you feel that the material is covered in greater depth?"

This question is closely related to the third question. If the response for the third question was less, you would expect the response to the fourth question to be yes. It would be unrealistic if a teacher responded yes to question #4 and more to question #3.

To cover more material in a block schedule than in a traditional schedule and in greater depth would seem impossible. The material might be covered in greater depth by reinforcing lecture with varied teaching styles like hands-on-projects, discussion, and group work.

Question #5: "Do you want to see a change in the current schedule?"

For this question, there are options of A) Yes, B) No, or C) Depends on what the alternative is. The responses to this question show if the faculty is satisfied/dissatisfied with block scheduling.

Question #6: "Number 1,2 or 3 the teaching styles most frequently used in your classroom: 1's being most frequently used, 3's being least frequently used."

	Lecture	Audio-Visual	Group work	Technology	Discussion	Hands–on Projects
Art						
English						
Music						
Health						
Social Studies						
Foreign Language						
Math						
Technology						
Science						

This question tries to determine what types of teaching styles are commonly used in the teacher's area of interest.

Question #7: "How has the block schedule impacted classroom discipline?"

For this question, the choices are A) Positively, B) Negatively or C) Not at all. This question could depend on the type of student. A student in the academic track would probably be more apt to act out than a student in the college/honors track. A student may become passive and even sleepy because of boredom. Conversely, students may become hyper for sitting around in one class for such a long period of time.

Question #8: "Does the 90 minute block allow for greater interaction with, and more individual attention to the students?"

Question #9: "Do you feel there are courses which need to be a full year?"

This question deals with coverage and progression in classes. For some classes, it is necessary to cover a minimum amount of material that will serve as proper background for the next successive class. For example, in a math class like Pre-Calculus it is necessary to cover a certain amount of material for proper background to Calculus. If the theory that less material is covered in a block schedule holds, then math suffers. In terms of progression, a class like foreign language might benefit from a year long schedule. If more time is needed to review material from a past class, then there is less time to learn new concepts. When the break between successive classes can last over a year, a great deal of time may be needed for review.

Question #10: "How has the block schedule impacted your subject area?"

From the answers filled in to this question, we hope to infer things about how each department feels about block scheduling.

Question #11: "What do you think the greatest drawbacks are to block scheduling at Leicester high School?"

Question #12: "What do you think the greatest strengths of block scheduling are at Leicester high School?"

4.2.3 Initial Observations

Question #6 was not analyzed due to the fact that the faculty did not answer it properly.

Faculty survey totals

Question #	Yes	No	Not Answered
1	4	16	4
2	10	12	2
4	17	3	2
8	18	4	2
9	23	1	0

Question #3	Less	Same	More	Not answered
	12	2	5	5

Question #5	Yes	No	Depends	Not answered
	4	5	15	0

Question #7	Positively	Negatively	Not at all	Not answered
	5	8	9	2

4.2.4 Statistical Significance

Statistical Significance results for questions with two possible responses:

Faculty Data Table

Question #	Yes	No	Other	Normalized "Yes"	Normalized "No"	P-value	Conclusion
1	4	16	4	5	20	.002	Very Strong significance
2	10	12	2	11	14	.345	Not significant
4	17	3	4	21	4	.0005	Very Strong significance
8	18	4	2	20	5	.002	Very Strong significance
9	23	1		24	1	<.00001	Very Strong significance

There was a very strong significant difference in faculty responses to whether or not they have difficulty teaching for 90 minutes, if they feel material is covered in greater depth, if the 90 minute block allows for greater interaction with students, and whether they feel there are courses that need to be a full year. The majority of faculty felt that it is not difficult to teach for 90 minutes and the material is covered in greater depth. They also felt that the 90-minute block allows for greater interaction with students and there are courses that need to be a full year.

Statistical Significance results for questions with three possible responses:

Faculty Data Table

	Same	More	Less	X^{2*}	P -value	Significance
Q #3	2	5	12	8.316	<.025	Strong

	Yes	No	Depends	X^{2*}	P -value	Significance
Q #5	4	5	15	9.25	<.01	Very strong

	Positively	Negatively	Not at all	X^{2*}	P –value	Significance
Q #7	5	8	9	1.19	<.9	Not

4.2.5 Faculty Conclusions

As a whole, the faculty of Leicester High School are undecided about whether the block schedule should remain, or whether it should be changed. This can be seen in the comments as well as to the responses to Question #5. The answers to Question #5 are spread fairly evenly: Four people want to see a change in the current schedule, 5 want to stick with the block schedule, and 15 would consider a change depending on the alternatives proposed. However, the faculty agree that modifications should be made. For example, twenty-three out of twenty four believe there are courses that need to be a full-year. The modifications apply not only to classes in general, but also to changes that need to be made in specific subject areas. When the responses are divided up by subject area, one can see more clearly the advantages and disadvantages of block scheduling.

The math department at Leicester High School seems the most concerned over the effects of block scheduling. One of the problems often associated with block scheduling is less coverage of material. In math, more than any other subject, this problem is magnified. In math, it is necessary to cover a minimum amount of material that will serve as background for the next successive class. For example, in a class like Algebra I, it is necessary to cover a minimum amount of material that will serve as a basis for Algebra II. As mentioned in section 2.2.5 of the Literature Review, there is a loss of total time in core subject areas of 8% with block scheduling. Obviously, with 8% less class time, not as much material can be covered. However, this is not the only reason cited for less coverage. Members of the math faculty feel that students can only grasp so many concepts in one day. Therefore, the faculty focus on presenting one new topic in class. This leads to more in depth coverage through labs, difficult exercises, exploration, and practice, but at the expense of the number of topics learned. Another factor effecting coverage of material is the time lag in successive classes. In the 4x4 schedule, there can be a layoff of up to a year between sequential subjects. With such a long break between classes, a greater amount of time is needed for review. The extra time that is needed for review, which would not be necessary in a traditional schedule, replaces the time where new material should be taught. One faculty member believes the lack of coverage has left "holes in the (students) math foundations."

The faculty in general seem to voice the same concerns as the math department in terms of coverage of material. For question #3, the faculty were asked "In comparison to the traditional seven period day, how much of the course syllabus are you able to cover under the current schedule?" The responses were broken down into the following: twelve teachers believe that less material is covered, 5 believe more is covered and 2 say there is no difference. Recalling from section 4.1.4 on Chi Square tests, our study begins with assuming H_o is true, or $p = .33$. The p-value quantifies how consistent the observed value of the test statistic is with H_o. The smaller the p-value, the greater the evidence in support of the alternate hypothesis, or $p \neq .33$. The p-value for this question was .025, which gave strong statistical evidence in favor of the alternate hypothesis ($p \neq .33$). This means there is strong statistical evidence that the responses were not equally distributed ($p \neq .33$).

Leicester High School realizes coverage is a major problem, and has taken steps to alleviate the situation. The Algebra I freshman college level class has been extended from the typical half-year to a full-year class. This action is the step in the right direction, but it is not a solution to the problem. Adjustments have to be made to all classes to account for the lack of coverage.

The science teachers at Leicester High School are the most supportive of block scheduling. One faculty member believes that "science avails itself to 90 minutes." A major advantage of the longer blocks for science is that more labs can be done, and they can be done more completely. In a traditional schedule, under time constraints, certain sections outlined in a lab exercise would have to be excluded. These sections may have played a role in the final results, but they had to be neglected. With the longer blocks, there is not a rush to finish the lab on time. When students are strapped for time, they focus on completing the procedures in lab and finding numbers that can be used to write the lab report. The extra time allows students to analyze results and gain a better grasp of the concepts trying to be relayed through the lab.

The science faculty also feel that there is less coverage of material. However, one member of the faculty embraces this because " less is more in the new science curriculum frameworks." The thinking here is that the why's and how's of concepts can be explored in greater detail and experiments can be used to back up material that is learned.

The teachers in general seem to agree that material is covered in greater depth in the block schedule. Seventeen members of the faculty feel that material is covered in greater depth, while only three feel there is no difference. The p-value for this question was .0005, which gave very strong statistical evidence in favor of the alternate hypothesis, or $p \neq .5$. This means there is strong statistical evidence that the responses were not equally distributed ($p \neq .5$), and therefore, we can conclude that material was covered in greater depth.

The history department is also concerned about the lack of coverage in material. One faculty member points out that "with each passing year, as we have to cover more history, it seems as if we're leaving more material untaught." Coverage is not as critical in history because history classes are usually independent of one another. For example, you are not required to have a strong background in U.S. History to take a course in Modern European History. This faculty member also points out that less coverage could result in lower MCAS scores. This could be a problem since MCAS scores will be a requirement for graduation starting in 2003. If there is material required by the MCAS that is not covered in class, it could hurt the student's score.

A member of the history faculty believes that "for gifted students it's (block scheduling) fine. (However) for average or below, it (90 minutes) is too long to keep their interest." The majority of the faculty (14 out of 22) agree that students in academic level classes have difficulty concentrating for 90 minutes. This could help explain the results of Question #7 on the faculty survey. As seen in section 4.2.3, the answers to how classroom discipline has been affected by block scheduling are split fairly evenly: eight people believe its negatively affected, 5 positively, and 9 believe it has no effect. One could make the assumption that if teachers were to have mostly academic level classes, they may have a negative view on classroom discipline. Conversely, if teachers were to have mostly college/honors classes, they may have a positive view on classroom discipline.

The English department points to the ability to use more varied teaching styles as a positive of block scheduling. One faculty member points out that "I can give multiple tasks for one piece of literature, which allows me to address different learning styles/strengths of students. With block scheduling there is more time for group work, discussion, comparisons of text and film, and project development." These remarks could help explain the results of Question #8 on the faculty survey. Question #8 asks the faculty whether "the 90 minute block allows for greater interaction with, and more individual attention to the students." Eighteen members of the faculty felt there is greater interaction with the students, while only four felt there is no difference. The p-value corresponding to this question was .002, or very strong significant evidence that the responses are not divided evenly ($p \neq .5$). Proponents of block scheduling have often said that by using different teaching styles there will be a stronger student-teacher bond than if a straight lecture format was used.

One member of the English faculty makes an interesting point concerning quality of classes and grade inflation. The teacher notes that "students develop an inflated perception because grades are usually better when he/she takes only 2 (maybe 3) truly academic classes ." In a schedule where 8 classes are taken during the entire year, only 5 of these are represented by core courses (English, science, math, history and foreign language), while the other three are taken as electives. In a traditional schedule, when 7 classes are taken, only two are filled with elective courses. It is a lot easier for a student to only worry about 2 (maybe 3) courses instead of the five academic courses they would encounter in a traditional schedule. It is obviously good if students feel they are doing well and have a positive attitude towards school. However, since they are only dealing with two (maybe 3) tough courses, they are not being challenged as they would in a traditional schedule.

The foreign language department seems worried about progression in classes. One faculty member points out that "(I) don't like the time lag (sometimes one full year) between levels of classes. For example, Spanish II ends in January and Spanish III begins in January of the following year. It would be nice if sequential scheduling could be done." As mentioned earlier, the time lag is a major problem that aids in the lack of coverage of new material.

A remark common to the faculty, which is echoed by the foreign language department, is that tension is low in the building. One faculty member believes this is because there are "fewer occasions for passing." The level of tension in a school system is an issue that has been brought to the forefront in the wake of recent high school shootings. With less passing time there is less opportunity for confrontation, which can lead to extreme behavior. The reason for the low tension at Leicester high School could be that students are not stressed out over school. This may be a result of not being challenged by class work, or they may simply have a positive attitude towards school.

Proponents of block scheduling have often said that longer blocks are beneficial to classes like art and music. The reasoning is that longer blocks would allow for one-on-one interaction with the students. One-on-one interaction is important in classes like art and music because other forms of teaching (i.e. lecture) do not play as big a role in student learning. The faculty members are split on whether block scheduling is of benefit in their respective subject areas. One teacher points out that "My classes are at maximum capacity (as far as seating goes). This makes it very hard to provide the one-on-one interaction that I have always felt is necessary in art for hands-on work." Conversely, another faculty member believes that "by far the 90 minute block allows for greater interaction with and more individual attention to the students." The problems in art can be traced back to the fact that there is only one instructor for the entire department. Many of the faculty voiced the need for more teachers, which would allow for greater course selections, and as a result, smaller classes.

The pro's and con's outlined in section 2.2.5 of the Literature Review mirror the comments and responses of the faculty. The only difference is the problems in block scheduling seem more severe than originally anticipated. Coverage in material should be a huge concern in the math department, and to a lesser extent the other departments. Lack of coverage will affect MCAS scores, SAT scores, and achievement after high school (i.e. being prepared for college courses). Other problems that must be addressed are the time lag of up to a year in certain classes and the student's inability to stay focused for 90 minutes. However, the advantages are evident. The longer blocks allow for in depth labs, have resulted in lower tension in the building and have aided student-teacher rapport. Whether these benefits outweigh the costs is open to interpretation. Either way, modifications need to be made to the current schedule to account for the three major problems – less coverage, time lag between classes, and students' short attention spans.

4.3 SAT Analysis

4.3.1 School Surveys

The first school survey was administered in May to 255 public high schools in Massachusetts. The initial survey produced some interesting findings. Of the 141 schools that responded, roughly half were still using a traditional schedule. This was unexpected because the Massachusetts Education Reform Act of 1994 made it practically impossible to maintain a traditional schedule without extending the school day. It is difficult to extend the school day because of teacher contracts and bus schedules. The results of the survey also showed a totally new schedule that we had not even considered. The first survey gave the school the option of a 4x4, 4x4 AB, Copernican, Traditional, or San Francisco Urban Plan. However, eight of the school systems that responded to the survey were using a 5 – period schedule. There are different variations of the 5 p, with 5 – 60 minute blocks, 3 traditional and 2 long blocks, a 7 period rotating schedule with 5 periods each day, etc. The first survey, which can be seen in the Appendix A-3, asked the school what type of schedule they were currently using and when this schedule began. When the first survey was administered, we were under the assumption that a school currently under the block schedule had been on a traditional schedule beforehand. However, the results from the first survey showed that this assumption was false. Many of the schools had switched between different types of block scheduling before adopting their current schedule. Since our analysis was going to be based on the fact that schools on a block schedule had switched from a traditional schedule, a second survey was needed to clarify the responses to the first survey.

The second survey was administered in September, to the schools that responded to the original survey, but whose answers needed clarification. The second survey, which can be seen in Appendix A-4, asked the school to fill in the type of schedule they were using for the years between 1994 and 1999. The choices were 4x4, 4x4AB, Copernican, Traditional, San Francisco Urban, 5p, and Other.

4.3.2 Analysis of Results

In the hopes of finding quantitative data to see the effects of block scheduling, an analysis of SAT scores was conducted. Using the SAT as a tool to try to measure academic performance, we hoped to see if a change in a high school's scheduling system had any effect. By observing what scheduling system a school was using and looking for any noticeable change in academic performance, we hope to see if any particular type of scheduling system proved superior to the rest.

To analyze the SAT data and its relation to high school scheduling systems, some more complicated statistical techniques had to be employed. Due to the importance of acquiring accurate results and the IQP team's unfamiliarity with the necessary statistics, specialists were brought in to analyze the data. These specialists were part of a statistical consulting team that was composed of graduate students at Worcester Polytechnic Institute. The following information below is a simplified summary of their procedures and findings. For a complete text on their procedures and findings, please reference the appendix for "High School Class Schedule Influence on SAT Scores".

The consultants started their analysis with a preliminary look at the data. Their observations noted that the data was composed of the mean combined SAT scores for 255 Massachusetts public high schools for each school for the years 1993 through 1998. Also noted was that the SAT scores for each school were not complete. Due to various difficulties, scores for 1994 were not acquired for any school and many other schools had missing entries. In a similar manner, the mean income from 1993-1998 was included in the data for many towns. The missing data for these two categories would prove to cause later difficulty in the analysis. Further information was presented in the data set that gave information on what scheduling system each school was using and when.

The first technique that was conducted on the data was to fit it to a simple linear regression model. Due to the small number of schools using any form of block scheduling prior to 1996, the data was fitted to this model for 1996-1998. Within this model, a schedule indicator variable, D, was placed to indicate whether or not a traditional or a block/5 period schedule was used. The variable X was also added to the model and represents the net income. The following is the general linear model that was used for the analysis:

$$Y_t = \beta_0 + \beta_1 D_t + \beta_2 X_t + \beta_{12} D_t * X_t + e_t, \ \ e_t \sim N(0, \sigma^2)$$

where the Y variable represents the SAT score response.

By conducting hypotheses testing on the general linear model, the statistical consultant team concluded what factors influenced the SAT score response. Their conclusions were that the "D" terms, which indicates whether or not the school was using a traditional schedule, played no significant role in determining the SAT response. The major factor that they found to affect the SAT response was the X term, which represents income. From this information, it appears that whether or not a high school uses a traditional or non-traditional schedule is irrelevant for determining SAT scores.

Though there didn't appear to be a difference in SAT scores based on whether or not a traditional schedule was used, it was felt necessary to test whether or not there were any significant differences between the SAT scores of high schools using various forms of non-traditional schedules. To see if there was any difference between the 5 non-traditional schedules (4x4, 4x4 AB, 5 Period, and Copernican), tests were conducted with a mixed model with repeated measures. The details of this test are more complicated than the previous simple linear regression model, but the general idea is similar. The complete technical details of this test can be easily referenced in section 3 of "High School Class Schedule Influence on SAT Scores" that can be found in the appendix. The general idea here is to conduct a hypothesis test on this new measurement model to see which factors had the most significance in affecting the SAT score response. Doing this allowed the creation of similar, yet more accurate models that excluded extraneous terms that had little significance. What is of most interest to us though is the findings that were made while trying to create this model. The findings of this test showed that no statistically significant difference could be seen on the SAT score response due to the differences of the five non-traditional schedules. However, they concluded that in this model, similar to the last one, the term involving income played the largest factor in affecting the SAT score response.

4.3.3 SAT Conclusions

From the results of the SAT analysis, one may conclude that scheduling has no apparent effect on the overall academic performance measure by the SAT. However, after consulting with the statistical team, it appears that with more data to fill in what was missing, a different conclusion might have resulted. The statistical consultants felt that due to the sparseness of the data and due to the size of a particular P-value that they obtained in one of the mixed models, it may be well worthwhile to re-do these tests at a later date. With that in mind, these tests appear to be inconclusive for the most part due to insufficient data.

5. Conclusions

The data for the student and faculty surveys revealed a great deal about the advantages and disadvantages of block scheduling. However, our analysis of the relationship between SAT scores and scheduling did not find any evidence against, or in favor of block scheduling. The results were inconclusive, due to missing SAT scores and the limited number of school survey responses. Therefore, our recommendations are based on conclusions found from analysis of student and faculty surveys.

From the analysis of survey data, it appears a change in schedule would benefit the students and faculty of Leicester High School. The results of both surveys showed that students at L.H.S. have difficulty concentrating for the entire 90-minute block. Unfortunately, this problem acts as the catalyst for other problems in the block schedule. The goal of Leicester High School should be to find a schedule that helps remedy this problem, while not taking away from the positives of block scheduling.

The analysis of student and faculty surveys showed that the longer blocks benefit science labs, tension is lower in the building, topics are covered in greater depth, and there is more time for student – teacher interaction. The negatives of block scheduling are that students have difficulty concentrating for 90 minutes, there is less coverage of material, and there are problems with the time lag between successive classes.

To solve the problem of time lag between successive classes, a 4x4 AB schedule could be implemented. Classes like math and foreign language, which suffer the most from the time lag, would be held every other day for the entire year. However, there are many drawbacks to this plan. The problem of student attention spans is not solved with the 4x4 AB schedule. Tension in the building might be higher with a 4x4 AB schedule than with a 4x4 schedule. This is because teachers would have to plan for 6 or 7 classes and students would have to worry about dealing with 8 classes. Faculty have said that because students are only dealing with two, maybe three academic courses in the 4x4 schedule, that they are not challenged or pressured by school.

Another alternative would be to revert back to a traditional schedule. The advantages of a traditional schedule are that students would be more focused during 45-50 minute blocks, and coverage would not be a problem because classes would be held an entire year. However, science labs could no longer be 90 minutes and students would have to deal with 7 classes. From faculty comments, it appears moving back to a traditional schedule would not be in the best interests of everyone involved. With 990 required structured learning hours, as issued by the Massachusetts Education Reform Act or 1993, it would be difficult to implement such a schedule.

Given that all the students are entering Leicester High school from a traditional system in the Leicester Middle School, it may be most beneficial to adopt a system that is closer to what the students are accustomed to. By choosing a schedule with this in mind, it would help to limit any detrimental affects to certain groups of students as opposed to choosing a scheduling system that best benefits only a certain group of students.

A schedule that is able to take advantage of the block and traditional schedule, while limiting the problems associated with these schedules, is the 5 period. There are numerous options on this plan – 1-90 minute block and 4-60 minute blocks, 2-90 minute blocks and 3-45 minute blocks, a 7 period schedule in a 5 period day, etc. The fact that the 5 p integrates more classes into its schedule than a block schedule makes it closer to a traditional schedule. Therefore, in theory, the transition from middle school to high school would be made easier.

The 5 p schedule, with 2-90 minute blocks and 3 –45 minute blocks, is a very good compromise between the traditional and block schedule. The classes would rotate day to day, so science would be able to take advantage of the 90-minute blocks. In this schedule, there would have to be 6-7 classes rotating on a 5 period a day schedule. In this situation, 1 or 2 classes would be left out each day. The drawbacks to this plan are that students and faculty would have to deal with 6 or 7 classes and the 2 long blocks would not solve the problem of student attention spans. However, the variety of having three shorter blocks with two long blocks might make it easier for the students to sit through the long blocks. High schools in Massachusetts currently using a schedule similar to this are Wareham High, Needham High, Norton High, and Norwood High.

Another schedule that seems promising is the 5 p with 5-68 minute blocks. This schedule could be employed in a number of ways. One way could be 7 classes rotating over a 5 period a day schedule for an entire year. This schedule appears to take advantage of the positives of block scheduling, while limiting the negatives. The 68-minute blocks are significantly shorter than the 90-minute blocks in the 4x4 schedule. In theory, students would be more conducive to learning with the shorter blocks. The classes would also appear to be long enough to benefit science labs. Other schools currently using a 5 p schedule are Walpole High, Dedham High, and Hopkinton High (see diskette for the scheduling system of 144 public high schools in Massachusetts).

The recommendations above are based on the responses of student and faculty surveys. However, a number of other factors have to be considered when weighing the decision to change a schedule. It is difficult to implement, and then adjust to a new schedule. The faculty have to alter their teaching styles to work within a new schedule. The problem for the students is two-fold, because not only do they have to adjust to a new schedule, but they also have to deal with the teacher's adjustment.

This study analyzed block scheduling and its effect on Leicester High School. Block Scheduling is a system where fewer, but longer classes are employed. The effects of block scheduling were investigated through analysis of SAT scores, student surveys, and faculty surveys. Although this study found no relationship between scheduling systems and SAT scores, student and faculty surveys revealed a great deal about block scheduling at L.H.S. It was recommended that a five period schedule be adopted.

6. Future Work

Scientifically trying to analyze and compare high school scheduling systems can be a difficult, time consuming, and complex task. This complexity has left some of the question that were hoped to be answered by this study unfulfilled as well as create new questions to be answered. Below is a brief listing of some of the tasks that future project groups could do to answer some unanswered questions.

One task that may be worth repeating in the future is the SAT analysis. Due to the sparse amount of data that was collected, the statistical consulting team didn't feel confident in concluding that there was no relation between SAT scores and a high school's scheduling system. With a more complete data set drawn out over a wider period of time, it will be easier to see if there is conclusively no relation between the SAT and scheduling systems, or if there is a relation that is slowly becoming present.

Another related task that could prove more difficult is to redo the SAT analysis, but instead of using the mean combined score, use the individual Math and Verbal scores. Since some proponents of block scheduling claim that their scheduling system can be of benefit to math and science, it may be interesting to see if this can be noticed in the SAT. If there is a measurable increase in the math SAT scores, but the combined mean SAT scores are staying the same, this would indicate that the math scores are rising at the expense of the verbal scores. It may be interesting for a project group to investigate this situation and to try to assess what, if any changes are attributed to scheduling systems. Analyzing these individual scores may be very helpful for future analysis, provided that whoever takes on this task can acquire the data. The difficulty in acquiring the math and verbal score data is the main reason why this study didn't perform that analysis.

Trying to more accurately identify which students are benefiting or being hindered by block scheduling could also be a useful project. By conducting further student surveys, it may be possible to see if students in standard academic level classes are having more difficulty with block scheduling than their peers in advanced classes. By being able to better identify which students are being more positively or negatively affected, it can eliminate some of the guesswork that is inherent in choosing the most appropriate scheduling system for a school.

7. Appendix

Grade______

BLOCK SCHEDULE SURVEY

1. Do you have difficulty concentrating for a 90 minute class period?

__Yes __No

2. Are you allowed time at the end of classes to begin homework, talk, or study? (Check one)

__Always __Sometimes __Never

3. Do you have difficulty making up work after absences?

__Yes __No

4. Do you feel enough electives are offered?

__Yes __No

5. What is the average amount of homework you are assigned each night? (Check one)

_Under 1 hour __1 - 2 hours __Over 2 hours

6. Number 1,2,or 3 the teaching styles most frequently used in your classes: 1's being most frequently used, 3's being the least frequently used.

	Lecture	Audio-Visual	Group Work	Technology	Discussion	Hands-on projects
Art						
English						
Music						
Health						
Social Studies						
Foreign Language						
Math						
Technology						
Science						

7. Is the use of video in your classes:

__Appropriate __Too frequent

8. Do you find progression in classes such as foreign language and math difficult because of the gap between classes?

__Yes __No

9. Do all classes need to be 90 minutes daily?

__Yes __No

10. If you could make one adjustment to block scheduling, what would it be?

11. Would you be willing to extend the school day by up to 6 minutes to allow for assemblies, class activities, etc.?

__Yes __No

12. Does it matter to you if there is any change in the current block schedule?

__Yes __No

13. Circle three from the following list of statements that you feel best describe the positive things about block scheduling at Leicester High School:

Classes only last ½ year

Increased science lab time

More variety in the classroom

Fewer classes to handle at one time

More in-depth study

Quiet school atmosphere

Ability to take more classes (8 each year)

***TRANSFER STUDENTS** (For students who have transferred into Leicester High School from another high school)

Did you find the adjustment to the block schedule difficult?

__Yes __No

If you transferred from a school with a more traditional 6 or 7 period day, which of the two schedules do you prefer?

__Block __6 or 7 period day

Block Schedule Teacher Survey

Feel free to comment (or not) after any of the questions.

1. Do you find it difficult to teach for 90 minutes?

___Yes ___No

Comment:

2. Do you find it hard to prepare sufficient work for your absences?

___Yes ___No

Comment:

3. In comparison to the traditional seven period day, how much of the course syllabus are you able to cover under the current schedule?

___Same amount ___More ___Less

Comment:

4. Do you feel that the material covered is covered in greater depth?

___Yes ___No

Comment:

5. Do you want to see a change in the current schedule?

__Yes __No __Depends on what the alternative is

6. Number 1, 2, or 3 the teaching styles most frequently used in your classroom: 1's being the most frequently used, 3's being the least.

	Lecture	Audio-visual	Group Work	Technology	Discussion	Hands-on projects
Art						
English						
Foreign Language						
Health						
Math						
Music						
Science						
Social Studies						
Technology						

7. How has the block schedule impacted classroom discipline?

__Positively __Negatively __Not at all

Comment:

8. Does the 90 minute block allow for greater interaction with, and more individual attention to, your students?

__Yes __No

9. Do you feel that there are courses which need to be full year?

__Yes __No

10. How has the block impacted your subject area? (Please name your subject area)

11. What do you think the greatest drawbacks are to block scheduling at Leicester High School?

12. What do you think the greatest strengths of block scheduling are at Leicester High School?

To whom it may concern:

We are currently working on a study that examines the effects of block scheduling on student attitudes and academic achievement. This study will involve looking at test scores from different schools and trying to determine if scheduling system has any affect. If you would be so kind as to answer the following questions, it would be greatly appreciated:

Of the choices below, which type of schedule most closely resembles the schedule employed in your school:

_____ 4x4 (four classes a day for half a year – then switch off to four new classes at the midway point in the academic year)

_____ 4x4 A,B (four classes one day – four different classes the next – switch off from day to day)

_____ Copernican (A Quarter system where there are four quarters in an academic year, with two classes each quarter)

_____ San Francisco Urban (A Trimester system where there is three semesters with four classes during each semester.)

_____ Traditional Schedule (Six to seven classes a day that run 45-50 minutes every day for the entire school year.)

During what year did this schedule begin?

_____ 1997-1998
_____ 1996-1997

_____ 1995-1996

_____ 1994-1995

_____ 1993-1994

_____ 1992-1993

_____ 1991-1992

_____ Other (before 1991)

If there is anything you would like to add concerning your opinion towards the scheduling system used at you school, please include in the space below:

This research project is part of a degree requirement for Worcester Polytechnic Institute. As part of the project, we are maintaining a web page, which we encourage you to access. The web page is http://www.wpi.edu/~mf/iqp.

If you could answer these two questions and drop it off in the postage paid, self-addressed stamped envelope that is enclosed, it would be of great benefit to our study.

Sincerely,

Joseph Dowgielewicz

4 Tanglewood Road
Leicester, MA 01524
(508)-892-9647

Mike Foss

660 N. Main Street
Mansfield, MA 02048
(508)-339-3120

To whom it may concern:

We are currently working on a study that examines the effects of block scheduling on student attitudes and achievement. The study will involve looking at test scores from different schools and trying to determine if scheduling system has any affect.

If you could fill in the timeline below with the type of schedule used during the different time frames, it would be greatly appreciated. Below is a list of schedules for your reference:

- 4x4 (Four classes a day for half a year – then switch off to four new classes at the midway point in the academic year)
- 4x4 AB (Four classes one day – four different classes the next – switch off from day to day)
- Copernican (A quarter system where there are four quarters in an academic year, with two classes each quarter)
- San Francisco Urban (A trimester system where there is three semesters with four classes during each semester)
- Traditional Schedule (Six to seven classes a day that run 45-50 minutes every day for the entire school year)
- 5 Period Schedule (5 classes a day)
- Other

If you could fill in the schedule used for each of the years below, it would be of great benefit to our study:

__________ 1994-1995

__________ 1995-1996

__________ 1996-1997

__________ 1997-1998

__________ 1998-1999

Critical values of the χ^2 distribution

k	$\chi^2_{k,0.005}$	$\chi^2_{k,0.010}$	$\chi^2_{k,0.025}$	$\chi^2_{k,0.050}$	$\chi^2_{k,0.100}$	$\chi^2_{k,0.900}$	$\chi^2_{k,0.950}$	$\chi^2_{k,0.975}$	$\chi^2_{k,0.990}$	$\chi^2_{k,0.995}$
1	0.000[a]	0.000[b]	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.60
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.34	12.84
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.14	13.28	14.86
5	0.412	0.554	0.831	1.145	1.610	9.236	11.07	12.83	15.09	16.75
6	0.676	0.872	1.237	1.635	2.204	10.64	12.59	14.45	16.81	18.55
7	0.989	1.239	1.690	2.167	2.833	12.02	14.07	16.01	18.48	20.28
8	1.344	1.646	2.180	2.733	3.490	13.36	15.51	17.53	20.09	21.95
9	1.735	2.088	2.700	3.325	4.168	14.68	16.92	19.02	21.67	23.59
10	2.156	2.558	3.247	3.940	4.865	15.99	18.31	20.48	23.21	25.19
11	2.603	3.053	3.816	4.575	5.578	17.28	19.68	21.92	24.72	26.76
12	3.074	3.571	4.404	5.226	6.304	18.55	21.03	23.34	26.22	28.30
13	3.565	4.107	5.009	5.892	7.042	19.81	22.36	24.74	27.69	29.82
14	4.075	4.660	5.629	6.571	7.790	21.06	23.68	26.12	29.14	31.32
15	4.601	5.229	6.262	7.261	8.547	22.31	25.00	27.49	30.58	32.80
16	5.142	5.812	6.908	7.962	9.312	23.54	26.30	28.85	32.00	34.27
17	5.697	6.408	7.564	8.672	10.09	24.77	27.59	30.19	33.41	35.72
18	6.265	7.015	8.231	9.390	10.86	25.99	28.87	31.53	34.81	37.16
19	6.844	7.633	8.907	10.12	11.65	27.20	30.14	32.85	36.19	38.58
20	7.434	8.260	9.591	10.85	12.44	28.41	31.41	34.17	37.57	40.00
21	8.034	8.897	10.28	11.59	13.24	29.62	32.67	35.48	38.93	41.40
22	8.643	9.542	10.98	12.34	14.04	30.81	33.92	36.78	40.29	42.80
23	9.260	10.20	11.69	13.09	14.85	32.01	35.17	38.08	41.64	44.18
24	9.886	10.86	12.40	13.85	15.66	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	34.38	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	36.74	40.11	43.19	46.96	49.64
28	12.46	13.56	15.31	16.93	18.94	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	40.26	43.77	46.98	50.89	53.67
35	17.19	18.51	20.57	22.47	24.80	46.06	49.80	53.20	57.34	60.27
40	20.71	22.16	24.43	26.51	29.05	51.81	55.76	59.34	63.69	66.77
45	24.31	25.90	28.37	30.61	33.35	57.51	61.66	65.41	69.96	73.17
50	27.99	29.71	32.36	34.76	37.69	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	85.53	90.53	95.02	100.4	104.2
80	51.17	53.54	57.15	60.39	64.28	96.58	101.9	106.6	112.3	116.3
90	59.20	61.75	65.65	69.13	73.29	107.6	113.1	118.1	124.1	128.3
100	67.33	70.06	74.22	77.93	82.36	118.5	124.3	129.6	135.8	140.2

[a]This value is actually 3.9×10^{-5}.
[b]This value is actually 1.6×10^{-4}.

A-6

TABLE A-III THE CUMULATIVE BINOMIAL DISTRIBUTION (Continued)

n	r	p = .10	p = .20	p = .25	p = .30	p = .40	p = .50
50	18		.99749	.97127	.85944	.33561	[illegible]
	19		.99907	.98608	.91520	.44648	[illegible]
	20		.99968	.99374	.95224	.56103	[illegible]
	21		.99990	.99738	.97491	.67014	[illegible]
	22		.99997	.99898	.98772	.76602	[illegible]
	23		.99999	.99963	.99441	.84383	[illegible]
	24		1.00000	.99988	.99763	.90219	[illegible]
	25			.99996	.99907	.94266	[illegible]
	26			.99999	.99966	.96859	[illegible]
	27			1.00000	.99988	.98397	[illegible]
	28				.99996	.99238	[illegible]
	29				.99999	.99664	[illegible]
	30				1.00000	.99863	[illegible]
	31					.99948	[illegible]
	32					.99982	[illegible]
	33					.99994	[illegible]
	34					.99998	[illegible]
	35					1.00000	[illegible]
	36						[illegible]
	37						[illegible]
	38						[illegible]
	39						[illegible]
	40						1.00000
100	0	.00003					
	1	.00032					
	2	.00194					
	3	.00784					
	4	.02371	.00000				
	5	.05758	.00002				
	6	.11716	.00008				
	7	.20605	.00028	.00000			
	8	.32087	.00086	.00001			
	9	.45129	.00233	.00004			
	10	.58316	.00570	.00014	.00000		
	11	.70303	.01257	.00039	.00001		
	12	.80182	.02533	.00103	.00002		
	13	.87612	.04691	.00246	.00006		
	14	.92743	.08044	.00542	.00016		
	15	.96011	.12851	.01108	.00040		
	16	.97940	.19234	.02111	.00097		
	17	.98999	.27119	.03763	.00216		
	18	.99542	.36209	.06301	.00452	.00000	
	19	.99802	.46016	.09953	.00889	.00001	
	20	.99919	.55946	.14883	.01646	.00002	
	21	.99969	.65403	.21144	.02883	.00004	
	22	.99989	.73893	.28637	.04787	.00011	
	23	.99996	.81091	.37018	.07553	.00025	
	24	.99999	.86865	.46167	.11357	.00056	
	25	1.00000	.91252	.55347	.16313	.00119	

TABLE A-III THE

n	r	p = .10
100	26	
	27	
	28	
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	72	

...ON (Continued)

	p = .40	p = .50
	.33561	.03245
	.44648	.05946
	.56103	.10132
	.67014	.16112
2	.76602	.23994
	.84383	.33591
3	.90219	.44386
7	.94266	.55614
6	.96859	.66409
8	.98397	.76006
6	.99238	.83888
9	.99664	.89868
0	.99863	.94054
	.99948	.96755
	.99982	.98358
	.99994	.99233
	.99998	.99670
	1.00000	.99870
		.99953
		.99985
		.99995
		.99999
		1.00000
00		
01		
02		
06		
16		
40		
97		
216		
452	.00000	
889	.00001	
646	.00002	
883	.00004	
787	.00011	
553	.00025	
357	.00056	
313	.00119	

TABLE A-III THE CUMULATIVE BINOMIAL DISTRIBUTION (Concluded)

n	r	p = .10	p = .20	p = .25	p = .30	p = .40	p = .50
100	26		.94417	.64174	.22440	.00240	
	27		.96585	.72238	.29637	.00460	.00000
	28		.97998	.79246	.37678	.00843	.00001
	29		.98875	.85046	.46234	.01478	.00002
	30		.99394	.89621	.54912	.02478	.00004
	31		.99687	.93065	.63311	.03985	.00009
	32		.99845	.95540	.71072	.06150	.00020
	33		.99926	.97241	.77926	.09125	.00044
	34		.99966	.98357	.83714	.13034	.00089
	35		.99985	.99059	.88392	.17947	.00176
	36		.99994	.99482	.92012	.23861	.00332
	37		.99998	.99725	.94695	.30681	.00602
	38		.99999	.99860	.96602	.38219	.01049
	39		1.00000	.99931	.97901	.46208	.01760
	40			.99968	.98750	.54329	.02844
	41			.99985	.99283	.62253	.04431
	42			.99994	.99603	.69674	.06661
	43			.99997	.99789	.76347	.09667
	44			.99999	.99891	.82110	.13563
	45			1.00000	.99946	.86891	.18410
	46				.99974	.90702	.24206
	47				.99988	.93621	.30865
	48				.99995	.95770	.38218
	49				.99998	.97290	.46021
	50				.99999	.98324	.53979
	51				1.00000	.98999	.61732
	52					.99424	.69135
	53					.99680	.79794
	54					.99829	.81590
	55					.99912	.86437
	56					.99956	.90333
	57					.99979	.93339
	58					.99990	.95569
	59					.99996	.97156
	60					.99998	.98240
	61					.99999	.98951
	62					1.00000	.99398
	63						.99668
	64						.99824
	65						.99911
	66						.99956
	67						.99980
	68						.99991
	69						.99996
	70						.99998
	71						.99999
	72						1.00000

Agreement Analysis for grade 10

X= Question #1
Y= Question #8
0 = No
1 = Yes

TABLE OF X BY Y

X \ Y (Frequency / Percent / Row Pct / Col Pct)	0	1	Total
0	47 39.17 78.33 58.75	13 10.83 21.67 32.50	60 50.00
1	33 27.50 55.00 41.25	27 22.50 45.00 67.50	60 50.00
Total	80 66.67	40 33.33	120 100.00

Simple Kappa Coefficient

Kappa	ASE	95% Confidence Bounds	
Kappa = 0.233	ASE = 0.084	0.069	0.397

Effective Sample Size = 120

Agreement Analysis for grade 11

X= Question #1
Y= Question #8
0 = No
1 = Yes

TABLE OF X BY Y

X: Frequency / Percent / Row Pct / Col Pct	Y: 0	Y: 1	Total
0	31 34.83 68.89 70.45	14 15.73 31.11 31.11	45 50.56
1	13 14.61 29.55 29.55	31 34.83 70.45 68.89	44 49.44
Total	44 49.44	45 50.56	89 100.00

Simple Kappa Coefficient

Kappa	ASE	95% Confidence Bounds	
Kappa = 0.393	ASE = 0.097	0.202	0.584

Effective Sample Size = 89

Agreement Analysis for grade 12

X= Question #1
Y= Question #8
0 = No
1 = Yes

TABLE OF X BY Y

X (Frequency / Percent / Row Pct / Col Pct)	Y = 0	Y = 1	Total
0	24 26.97 66.67 51.06	12 13.48 33.33 28.57	36 40.45
1	23 25.84 43.40 48.94	30 33.71 56.60 71.43	53 59.55
Total	47 52.81	42 47.19	89 100.00

Simple Kappa Coefficient

Kappa	ASE	95% Confidence Bounds	
Kappa = 0.222	ASE = 0.100	0.026	0.418

Sample Size = 89

High School Class Schedule Influence on SAT Scores

By: Samuel T. Lehane-Abraham and Lan Huang
Advisor: Professor Joseph D. Petruccelli
Clients: Joseph Francis Dowgielewicz and Michael Foss

Nov 12,1999

Abstract

This project involves testing 5 different high school class scheduling systems versus the traditional one. Average town income of each high school included in this analysis is used as a covariate. The data used for this study is very sparse and requires special attention. Mixed modeling is used to separate fixed and random effects, in order to adequately measure the effect of each schedule. It is found that town income has a strong influence on SAT scores and that class schedules do not.

1 Introduction

Due to various factors, most Massachusetts high schools have found it necessary over the past seven years to adopt a block scheduling system. In this report, five different scheduling systems are considered. The purpose of this analysis is to see whether these scheduling systems directly impact high school students' SAT scores. Town wealth is also considered as a covariate. This is measured through the average income index of a town. A sample of Massachusetts high schools is considered for this analysis, along with five scheduling systems over a period of five years.

- Traditional Schedule

A traditional schedule generally has six to seven classes that run for 45-50 minutes a day, for the entire school year. The classes might be on a rotating block, with a schedule that might look like this: Day 1 - ABCDEF (where the different letters correspond to class blocks), Day 2 - BCDEFA, Day 3 - CDEFAB, Day 4 - DEFABC, Day 5 - EFABCD and Day 6 - FABCDE. This example refers to a school having six classes a day. Once the six day rotating schedule is completed, the schedule goes back to "Day 1," where the A block is first again. This cycle continues for 180 school days. This schedule could also be used for seven classes, which would work on a seven day rotating schedule. It is possible for a school to run six or seven classes, having class at the same time every day for the whole year. The class blocks would not rotate, and classes might run ABCDEF every day for the entire year.

- 4x4 Schedule

In the 4x4 plan, all standard yearlong classes from a traditional schedule are converted into half-year long courses of 90-minute classes. A student takes a total of four classes each day. The teachers teach three classes per day with either a 90-minute prep period or a 45-minute prep period and a duty. At the mid-year point, around January, the students and teachers change over to a new schedule. In some situations, there may be a class that runs for an entire year, which meets for 90 minutes each day. When this occurs, there obviously would be no changeover to new class at the halfway point.

- 4x4 A,B Schedule

The 4x4 A,B plan is very similar to the 4X4 plan. The only difference is the fact that every other day the student has four different classes. The student is carrying eight classes for the entire year.

- Copernican Plan Schedule

In the Copernican Plan, a student has just two classes per day. The classes meet for 180 minutes and are completed in just 30 school days. At the end of the 30 school days, the students and teachers change over to a new pair of classes.

- San Francisco Urban Plan (5 period) Schedule

In the San Francisco Urban Plan, there are three semesters of 12 weeks each. In this type of block scheduling, students take 12 classes in an academic year. What was a yearlong course in a traditional schedule is covered in 24 weeks under the San Francisco Urban Plan. Therefore, the five core courses, math, science, history, foreign language and English, would make up ten of the twelve courses taken during the year. The other two classes might be taken in music, physical education, art, etc. This schedule is also very similar to the 4x4 plan, as classes run for 90 minutes each.

2 Preliminary Analyses

2.1 Preliminary Analysis of the Data

The data consists of mean SAT scores for 255 public high schools, each from different towns in Massachusetts, with the exception of vocational and trade schools. The data spans five years for each town, 1993 to 1998 excluding 1994. During any of these years, a school could switch to a new scheduling system, or remain with the current (traditional) syatem. There is also data for the mean income for each town for each year from 1993 to 1998, including 1994. However, the data is very sparse as there is only income data for a little less than half of the towns. The SAT score data is also very limiting, as very few towns have data for all five years. Many of the towns did not stray from the traditional scheduling system as well.

Table 1: Summary of the Data

	Mean SAT Score			Mean Income		
Year	X	N	s	X	N	s
1993	1042.35	26	45.51	26073.31	105	5243.11
1994		0		26821.69	105	5548.38
1995	996.71	143	71.39	27881.11	105	6005.37
1996	1022.79	86	62.99	29073.76	105	6557.74
1997	1016.38	104	65.66	30503.07	105	7092.47
1998	1006.24	143	71.18	32058.34	104	7714.42
1999	981.91	122	93.71		0	

From the summary of the data shown in Table 1, it can be seen that the number of observations (N) for SAT scores varies for each year. Table 1 also shows no SAT data for 1994, and no income data for 1999. The average income for each year also seems to be increasing over six years. This phenomenom could be the result of economic factors, such as inflation. Also of interest is the fact that there is income data for 105 of the same towns from 1993 to 1998, with the exception of one missing town data in 1998. Table 2 gives summary statistics broken down by traditional versus other scheduling.

Table 2: Traditional vs. Other Scheduling

	Traditional Schedule			Other Schedule		
Year	X	N	s	X	N	s
1993	1042.35	26	45.51		0	
1994		0			0	
1995	998.22	134	71.40	974.22	9	71.50
1996	1021.68	73	64.41	1029.00	13	56.28
1997	1021.29	77	68.54	1002.37	27	55.40
1998	1007.75	85	80.32	1004.03	58	55.72
1999	973.89	63	108.57	990.47	59	74.67

According to Table 2, there appear to be similar trends in average SAT scores per year. It is still difficult to see whether there is a difference in mean SAT scores between traditional and other schedules.

2.2 Simple Linear Regression Model

It is of interest to see whether there are significant differences among the individual schedules. Before 1996, the number of schools which changed their schedule is very small (see Table 3). The data from that year does not have enough representation and may not have enough information to support our model fitting. Therefore, a simple model was fitted for the years

1996, 1997, and 1998, in order to get a rough idea about the schedule effect in the three years.

Table 3: Number of schools with new schedule in each year

SCHEDULE	YEAR	N
4x4	1993	1
4x4	1994	2
4x4	1995	6
4x4	1996	11
4x4	1997	20
4x4	1998	35
4x4	1999	35
4x4 A,B	1994	1
4x4 A,B	1995	3
4x4 A,B	1996	7
4x4 A,B	1997	11
4x4 A,B	1998	15
4x4 A,B	1999	16
5 period	1996	2
5 period	1997	3
5 period	1998	7
5 period	1999	8
Copernican	1998	1
Copernican	1999	1

To model the difference between mean SAT scores for traditional and other schedules, a schedule indicator variable was created. This indicator variable is 0 when a traditional schedule is used, and 1 if any new schedule is adopted. Define the response Y to be the total SAT score, X as the net income covariate, and D as the schedule indicator variable. General linear models were fit for years t from 1996 to 1998. The 1996 model's interaction parameter estimate had a value less than 0.0001 and was assumed to be negligible.

$$Y_t = \beta_0 + \beta_1 D_t + \beta_2 X_t + \beta_{12} D_t * X_t + e_t, \quad e_t \sim N(0, \sigma^2)$$

1996 model: $\widehat{Y}_{96} = 922.4290 + 23.8758 * D_{96} + 0.0031 * X_{96}$

1997 model: $\widehat{Y}_{97} = 903.7166 + 12.1225 * D_{97} + 0.0037 * X_{97} - 0.0010 * (D_{97} * X_{97})$

1998 model: $\widehat{Y}_{98} = 886.5027 + 36.9486 * D_{98} + 0.0040 * X_{98} - 0.0014 * (D_{98} * X_{98})$

Table 4: Simple model result for year 96, 97,98 (type III)

Year	N	D p-value	X p-value	D*X p-value	R^2	Model p-value
1996	86	0.6909	0.0053	0.8288	0.1270	0.0165
1997	104	0.6875	0.0002	0.4979	0.2257	0.0001
1998	143	0.8058	0.0001	0.5256	0.1799	0.0002

All models show a positive relationship between the SAT scores and average income in 1996, 1997, and 1998. The P-values for H_0:$\beta_2 = 0$ in all three years are less than than 0.05, so at the 0.05 significance level H_0:$\beta_2 = 0$ can be rejected. The effect of income is important. In each year, there is a postitive association between mean town income and mean SAT score. The effect of D_t is not statistically significant at the 0.05 significance level. Statistically, the new block schedule system does not show any difference with the traditional schedule. The R^2 values are not large. The 1997 and 1998 models explain about 20% of the variation in the response. The 1996 model explains approximately 13%. In all three models, there is no significant interaction between D and X.

In the models for 1996 and 1997, one town record (LAWRENCE) was deleted because all of its SAT scores are very low. They are lower than the first qauntile of SAT scores for all schools over all years. This makes LAWRENCE's score a significant outlier, so it was excluded from the analysis. After deleting LAWRENCE, the residuals passed the Shapiro-Wilk normality test (From Table 4, the P-values are all greater than 0.05 for the normal test, so H_0:$e \sim N(0,\sigma^2)$) is not rejected. The Q-Q plot for the residuals looks linear, the histogram also looks symmetric. All of these factors support the model's normal residual assumption.

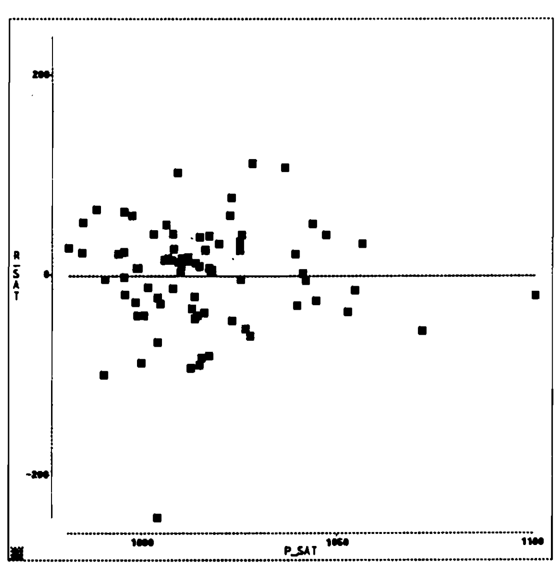

Figure 1: Residual vs Predicted Values Plot for 1996 Model

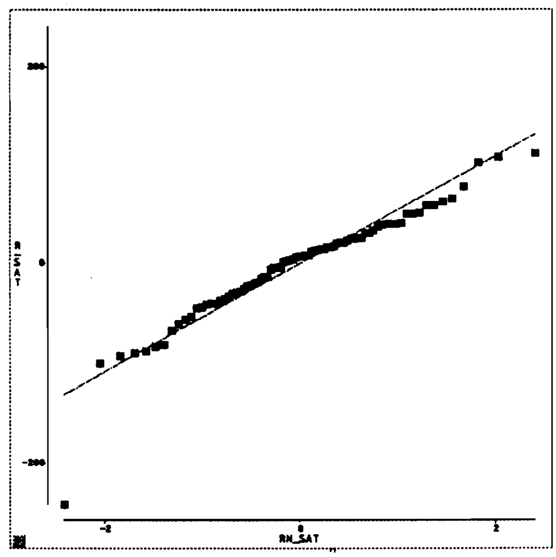

Figure 2: Q-Q Plot for 1996 Model

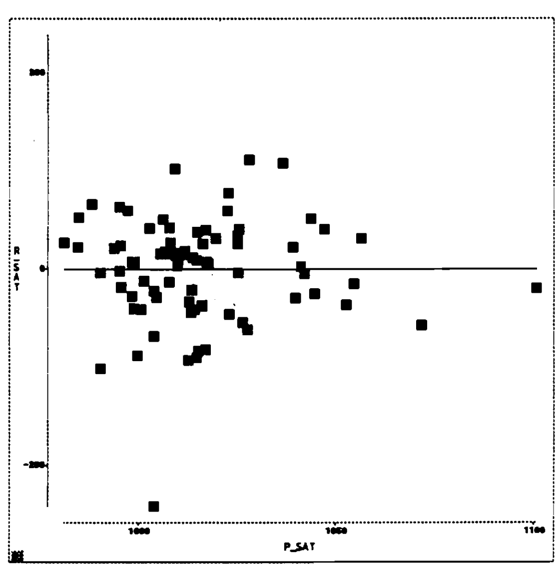

Figure 3: Residual vs Predicted Values Plot for 1997 Model

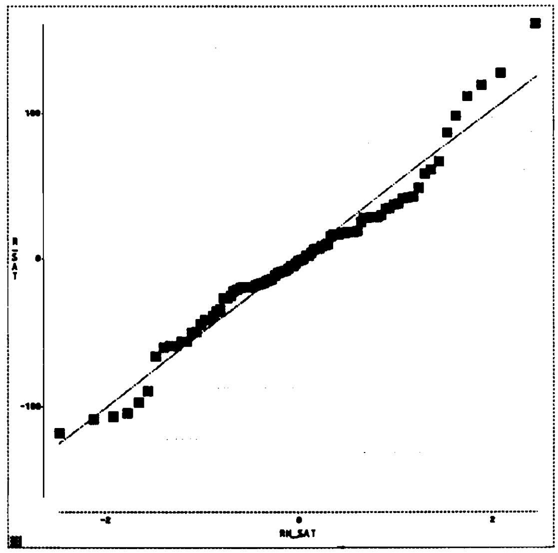

Figure 4: Q-Q Plot for 1997 Model

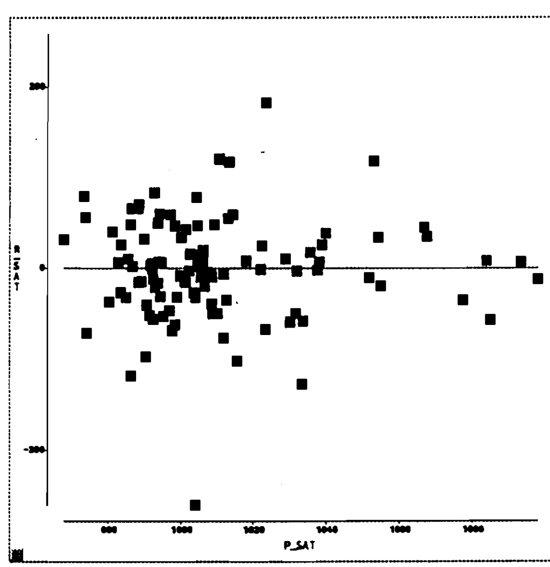

Figure 5: Residual vs Predicted Values Plot for 1998 Model

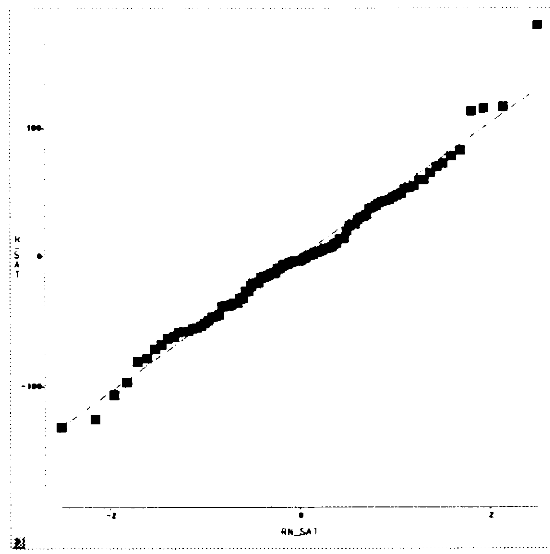

Figure 6: Q-Q Plot for 1998 Model

3 Mixed Models with Repeated Measures

3.1 Mixed Model 1

In order to model the multi-year patterns in the data, a repeated-measures model was formulated. The model is:

$$Y_{jkt} = \underbrace{\mu + \alpha_k + \beta \cdot X_{jt} + \tau_t}_{fixed\ effects} + \underbrace{d_j + e_{jt}}_{random\ effects}$$

where
k=1,2,3,4,5 denotes the schedules. j=1,..., r_k, r_k is the total number of schools
t=93,95,96,97,98 (1994 and 1999 are not included in the calculation due to missing values of Y and X respectively).
Y_{jkt} is the mean SAT score at school j having schedule k in year t.
α_k is the effect of the schedule k.
X_{jt} is the mean town income associated with the j^{th} school having schedule k at year t.
τ_t is the effect of each year, over all schedules and schools. This takes into account the effect of changing values over time.
$d_{j(k)}$ is the random effect associated with the j^{th} school.
$e_{j(k)t}$ is random error associated with the j^{th} school having schedule k at year t.
μ,α_k,β and τ_t are fixed parameters such that the mean for school j having schedule k at year t is $\mu_t = \mu + \alpha_k + \beta \cdot X_{jt} + \tau_t$.
This time, the 5 schedules(4*4, 4*4 AB, 5 period, Copernican, Traditional) are compared individually.

Each observed SAT score is independent across all towns. As a consequence, $\text{Cov}(Y_{jt}, Y_{it}) = 0$, when $i \neq j$. The correlation within schools is measured by:

$$\mathrm{Corr}(Y_{jt_0}, Y_{jt_1}) = \frac{\sigma_d^2}{\sigma_d^2 + \sigma_e^2}$$

The higher the model error is, the less correlation there is between towns.

In order to get normal residuals, a transformation for dependent variable y_{jt} and independent variables X_{jt} is desirable. However, once the outlier town LAWRENCE is excluded from our calculation, a normal residuals plot is obtained even without any transformation.

Table 5: Mixed Model 1 Results

Effect	F*	P-value
α_k	0.41	0.8044
τ_t	0.71	0.4006
X_{jt}	25.23	**0.0001**

Table 5 shows a significant association of income (X) with the SAT scores (P-values smaller than 0.0001), and a non-significant effect of schedules and years on SAT scores. Consequently, the P-value for testing H_0: $\beta = 0$ is 0.8, which is much larger than 0.05. This implies that there is no different effect of the five schedules (4x4, 4x4 AB, 5 period, Copernican, and traditional) on SAT scores.

The P-value from the Shapiro-Wilk normality test is 0.1925, which is greater than 0.05. Normal assumptions at the 0.05 critical level are kept.

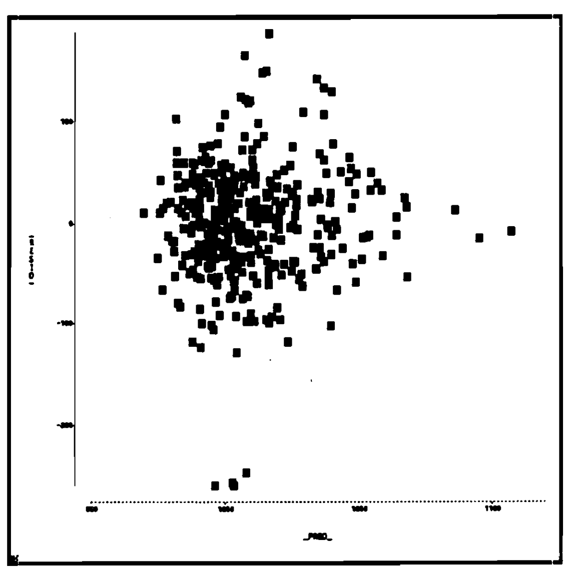

Figure 7: Residuals vs Predicted Values Plot for Mixed Model 1

3.2 Mixed Model 2

Since the years are not a significant factor, they will be taken out of the model. The general linear model is fit again to test whether the schedules are significant, even though the schedules turn out to not be significant in the previous model.

$$Y_{jkt} = \underbrace{\mu + \alpha_k + \beta \cdot X_{jt} + \tau_t}_{fixed\ effects} + \underbrace{d_j + e_{jt}}_{random\ effects}$$

$$Y_{jkt} = \underbrace{\mu + \alpha_k + \beta \cdot X_{jt}}_{fixed\ effects} + \underbrace{d_j + e_{j(k)t}}_{random\ effects}$$

Table 6: Mixed Model 2 Results

Effect	F*	P-value
α_j	0.68	0.6049
X_{jt}	26.33	**0.0001**

According to Table 6, average income (with P-value = 0.0001) still has a significant effect on SAT scores, but schedule (with P-value 0.6) does not. From the Shapiro-Wilk normality test, the P-value is 0.1535, which is greater than 0.05, so the residuals' normal assumptions are kept.

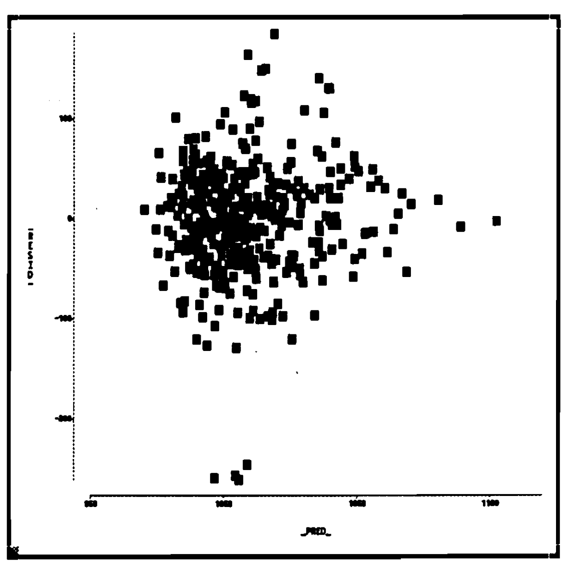

Figure 8: Residuals vs Predicted Values Plot for Mixed Model 2

3.3 Mixed Model 3

Mixed Models 1 and 2 show that schedule 5 (the San Fransisco Urban Plan) does not have a significant effect on SAT scores. This is good news, since the schools can change their schedules at any year, or stay with the traditional one. This is since the four new schedules do not have a significant association with SAT scores.

In order to test whether there is a difference between the traditional schedule and new schedules, the four new schedules are grouped together and compared with the traditional schedule.

$$\mathrm{Y}_{jt} = \mu + \beta_1 \cdot \mathrm{D}_{jt} + \beta_2 \cdot X_{jt} + e_{jt}$$

The variable D_{jt} is a schedule indicator variable similar to the one discussed in Section 2.2. It has two categorical values indicating whether or not a school is using the traditional schedule at year t. This indicator variable D_{jt} groups all new schedules into a single category. The coefficients μ, β_1, and β_2 are taken as trivariate normal random variables (that is, a random coeffiecient model is used).

Table 7: Mixed Model 2 Results

Effect	F^*	P-value
β_1	2.63	0.1060
β_2	27.30	**0.0001**

Table 7 shows tests for the means of β_1 and β_2. As Table 7 shows, type of schedule (old or new) is not associated with change in SAT scores. However, income is always associated with the change of SAT scores.

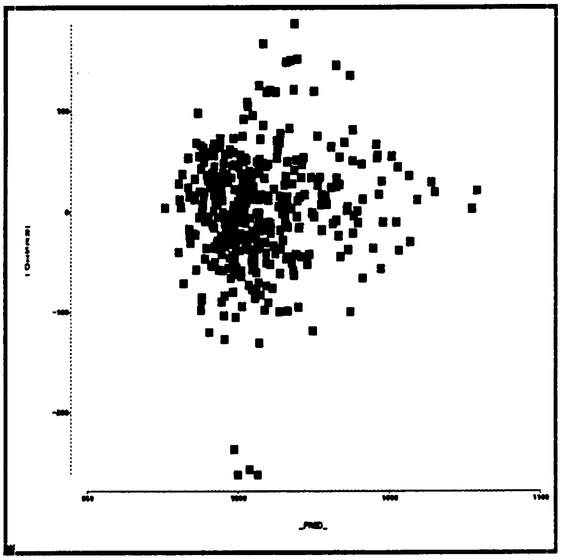

Figure 9: Residuals vs Predicted Values Plot for Mixed Model 3

4 Conclusions

From all of the analyses performed, there is no indication that changing to any new schedules has any impact on students' mean SAT scores. However income is strongly associated with SAT scores. In order to adequately study the effect of income on SAT scores, it is important to take into account many factors, for example inflation.

Judging by the size of the P-value for the indicator variable in Mixed Model 3, it may be worthwhile to redo this study with more data to work with. In the case of this study, the data was extremely sparse. But if enough data is collected, there is a chance of obtaining a different outcome than that from the analyses performed in this report.

5 Appendix - SAS Code

```
data sasuser.incsat3;
set sasuser.incsat3;
if schedule="4*4" | schedule="4*4 AB" | schedule="5 period" |
   schedule="Copernican" then indic=1;
if schedule="traditional" then indic=0;
run;

data incsat96;
 set sasuser.incsat3;
 if year^=1996 then delete;
run;

data incsat97;
 set sasuser.incsat3;
 if year^=1997 then delete;
run;

data incsat98;
 set sasuser.incsat3;
 if year^=1998 then delete;
run;

/*detect the cor of inc and indic, 99 no inc , so cut*/
data two;
 set sasuser.incsat3;
 if year=1999 then delete;
run;

proc sort data=two;
 by year;
run;

proc corr data=two;
 var indic inc;
 by year;
run;

proc sort data=two;
 by school;
run;

data incsat96;
 set incsat96;
```

```
 obs=_n_;
 if obs=62 then delete;
run;

proc reg data= incsat96;
 **class indic;
 model sat=indic inc indic*inc;
 output out=out96 r=res96 p=pre96;
run;

proc univariate data=out96 plot normal;
 var res96;
run;

/*the outlier 62 , when i did loglog transf, no sign to diesppear, so
i dicede to cut it, it's school Lawrence 1996, sat=0.638(loglog(sat),
inc 26530, indic=0, */

data incs972;
 set incsat97;
 sat2=sat**2;
run;

proc glm data=incs972;
 class indic;
 model sat2=indic inc indic*inc;
 output out=out972 r=res97 p=pre97;
run;

proc univariate data=out972 plot normal;
 var res97;
run;

/*still not good, cut outlier 62, which is LAWRENCE 1997,
sat=748,inc,28603; indic=0*/

data incs973;
 set incs972;
 obs=_n_;
 if obs=62 then delete;
run;

data incs973;
 set incs973;
 sat2=log(sat2);
```

```
run;

proc glm data=incs973;
 class indic;
 model sat2=indic inc indic*inc;
 output out=out97 r=res97 p=pre97;
run;

proc glm data=incsat98;
 class indic;
 model sat=indic inc indic*inc;
 output out=out98 r=res98 p=pre98;
run;

proc univariate data=out98 plot normal;
 var res98;
run;

/*Mixed model with repeated measures*/
data one;
 set sasuser.incsat3;
 if schedule="4*4" | schedule="4*4 AB" | schedule="5 period" |
 schedule="Copernican" then indic=1;
 if schedule="traditional" then indic=0;
run;

data one;
 set one;
 length year2 $ 4;
 if year=1993 then year2="1993";
 if year=1994 then year2="1994";
 if year=1995 then year2="1995";
 if year=1996 then year2="1996";
 if year=1997 then year2="1997";
 if year=1998 then year2="1998";
 if year=1999 then year2="1999";
run;

data two;
 set one;
 obs=_n_;
 **if obs=430 then delete;
 **if obs=431 then delete;
 **if obs=432 then delete;
 if school="LAWRENCE" then delete;
```

```
run;

proc mixed data=two;
 class schedule school year2;
 model sat=indic  inc / p;
 repeated year2/type=ar(1) sub=school;
 make 'predicted' out=p noprint;
run;

proc univariate data=p plot normal;;
 var resid;
run;

quit;
```

Town Average Income Table A9

Town	1993	1994	1995	1996	1997	1998
WARE	23,028	24,758	25,150	25,543	26,153	26,503
DENNIS-YARMOUTH						
CHATHAM	20,393	20,510	21,338	21,859	23,103	23,930
GREENFIELD	20,937	21,361	21,754	22,423	23,423	25,207
HOPEDALE	27,322	28,477	28,648	29,857	31,808	33,092
TAUNTON	24,946	26,458	26,724	27,741	28,500	30,430
LEICESTER	21,764	22,268	24,998	26,092	26,633	27,415
SANDWICH	23,289	23,379	23,878	23,836	24,579	27,534
UXBRIDGE	20,776	22,070	22,849	23,357	24,255	25,899
WEBSTER	23,246	23,495	23,815	25,432	26,791	29,492
WESTPORT	18,734	18,685	19,767	20,596	22,242	23,015
CHELMSFORD	28,952	30,703	34,580	38,003	40,560	45,937
FRONTIER						
GRANBY	21,059	23,889	22,386	22,901	25,254	25,888
HUDSON	33,462	33,470	34,829	38,226	42,071	43,804
METHUEN	22,510	23,577	24,599	26,547	28,050	29,256
NANTUCKET	23,707	24,556	25,473	26,695	28,323	29,851
QUABBIN						
WEST BOYLSTON	23,638	23,714	24,752	24,983	25,784	26,159
WHITMAN-HANSON						
AMESBURY	27,466	28,037	28,606	27,453	29,482	32,523
ANDOVER	36,260	37,432	41,207	43,261	48,404	46,275
ATHOL-ROYALSTON	22,123	22,400	23,467	24,548	26,010	27,051
AYER	28,430	$28,512	$29,553	31,058	33,179	34,485
BRISTOL-PLYMOUTH VOCATIONAL						
DARTMOUTH	19,709	21,197	20,888	23,277	23,999	24,964
EAST LONGMEADOW	26,780	27,508	28,323	29,348	30,235	
EASTHAMPTON	23,942	23,975	23,946	24,971	26,373	27,342
FAIRHAVEN	18,034	18,538	21,056	22,164	22,461	23,891
GROTON-DUNSTABLE						
HAMPDEN WILBRAHAM						
MILFORD	25,177	27,984	28,109	29,684	31,818	35,164
SOUTHWICK	19,052	20,050	20,492	20,885	20,787	22,647
TANTASQUA						
WINTHROP	21,822	21,442	28,090	29,650	28,934	27,436
SOUTHERN WORCESTER COUNTY (BAY PATH)						
DUXBURY	23,671	24,597	26,305	28,981	30,310	32,216
WEST BRIDGEWATER	33,600	24,103	26,604	28,768	28,931	29,821
BOURNE	21,586	22,432	22,827	24,061	25,580	32,067
LINCOLN-SUDBURY						
NORTHBRIDGE	26,322	25,910	27,740	27,570	27,776	27,366
SILVER LAKE						
GRAFTON	29,707	30,626	32,188	33,432	36,943	35,591
MARSHFIELD	23,785	25,981	24,775	24,772	27,244	27,914
SCITUATE	22,420	22,824	22,627	24,389	24,581	25,731
WAREHAM	25,313	24,314	24,497	25,219	26,336	26,689

MARTHAS VINEYARD						
MIDDLEBOROUGH	27,496	28,178	29,843	29,919	31,156	32,921
OLD ROCHESTER						
STONEHAM	25,040	26,989	27,223	29,032	30,775	32,651
NORTH READING	29,578	31,068	31,865	32,782	34,920	35,982
BARNSTABLE	22,884	23,729	24,381	25,545	26,414	28,125
HOPKINTON	43,736	50,445	52,851	58,400	59,024	67,639
RANDOLPH	29,944	28,662	29,764	30,490	33,535	35,432
DANVERS	27,411	27,518	28,838	30,100	31,416	33,715
NEEDHAM						
NORTON	24,558	27,088	27,847	28,547	31,069	31,392
NORWOOD	33,301	35,183	37,268	39,770	41,586	43,151
WALPOLE	26,496	27,113	28,163	27,923	29,886	30,980
GEORGETOWN	25,646	26,479	27,367	30,124	30,423	33,357
CLINTON	27,022	28,737	29,676	30,844	33,687	34,503
BERKSHIRE HILLS						
BELLINGHAM	23,107	22,743	22,669	23,729	24,243	24,286
ABINGTON	21,836	22,159	22,537	23,730	24,048	24,980
AGAWAM	22,029	22,466	23,648	23,848	25,375	26,557
BELCHERTOWN	17,677	19,523	19,535	20,280	21,247	22,064
BURLINGTON	36,028	38,032	40,455	42,411	46,469	50,124
CONCORD CARLISLE						
DRACUT	21,748	22,973	23,535	24,885	25,663	26,314
DUDLEY-CHARLTON						
GARDNER	24,851	25,678	26,381	27,038	27,589	29,811
MARLBOROUGH						
MEDWAY	23,559	22,958	27,668	29,101	29,957	30,842
MILLBURY	27,616	27,711	28,256	29,432	30,395	30,821
NORTH ANDOVER	35,102	36,994	40,116	38,699	40,245	41,695
READING	30,369	32,522	32,661	33,582	35,714	37,676
REVERE	22,570	22,822	22,185	22,096	23,197	25,202
ROCKPORT	17,870	18,129	19,393	20,323	21,185	21,935
SHREWSBURY	27,978	29,117	31,450	33,524	35,052	38,161
SOMERSET	22,667	23,281	23,995	24,756	25,874	28,393
WATERTOWN	29,679	30,244	31,451	33,854	33,651	36,297
WAYLAND	34,197	33,531	33,445	34,422	30,336	34,562
WESTFIELD	25,756	26,604	26,841	26,681	28,222	29,023
WEYMOUTH	25,224	26,167	26,571	27,739	28,697	29,576
WINCHESTER	27,668	27,396	28,300	29,153	30,798	31,985
BLACKSTONE-MILLVILLE						
FREETOWN-LAKEVILLE						
SOUTH SHORE (VOCATIONAL)						
BILLERICA	37,532	37,886	40,792	42,982	45,112	48,261
BRIDGEWATER-RAYNHAM						
DEDHAM	27,338	28,116	28,760	31,070	33,273	34,256
DOVER-SHERBORN						
EAST BRIDGEWATER	27,725	27,447	29,604	30,560	27,505	28,918
MANSFIELD	34,203	35,547	41,825	38,932	40,252	42,537
NORTH ADAMS	20,408	20,895	21,421	22,759	23,771	24,851
NORTHBORO-SOUTHBORO						
TRITON						

WESTBOROUGH	34,937	36,110	37,579	40,616	47,606	45,556
MELROSE	24,742	25,962	26,984	28,313	29,261	29,799
SWANSEA	15,921	16,590	17,194	19,099	19,139	20,515
ARLINGTON	25,097	25,413	26,135	27,093	30,357	32,268
WACHUSETT						
ACTON-BOXBOROUGH	32,251	32,677	33,987	37,145	40,129	42,013
ADAMS-CHESIRE	23,337	24,457	24,869	24,947	25,677	27,136
AUBURN	23,558	24,387	25,362	25,746	26,718	27,257
AVON	30,716	31,819	32,698	34,255	35,137	37,090
BROOKLINE	27,585	28,074	27,732	28,247	29,786	31,320
CANTON	34,788	35,016	37,661	39,023	39,523	42,360
CENTRAL BERKSHIRE						
CHICOPEE	24,788	25,502	26,255	27,830	28,019	29,025
EASTON	23,630	24,361	25,466	27,294	28,848	30,179
FRANKLIN	28,497	28,693	30,073	30,826	33,068	34,204
GLOUCESTER	26,164	26,819	27,553	28,534	29,846	30,854
GREATER LAWRENCE (VOCATIONAL)						
HAMPSHIRE						
HANOVER	22,348	22,923	23,738	26,197	27,445	28,712
HAVERHILL	24,134	24,785	25,938	26,762	27,910	29,806
HOLYOKE	23,647	24,106	24,867	25,653	26,457	27,469
LAWRENCE	26,916	26,916	26,970	26,530	28,603	29,714
LITTLETON	43,299	44,232	46,167	48,604	51,019	53,397
LOWELL	29,669	29,880	29,911	29,360	30,628	32,571
LUNENBURG	23,435	24,387	23,852	23,797	25,012	27,077
MONSON	21,815	23,369	24,253	24,779	27,008	27,949
MONTACHUSETT (VOCATIONAL)						
NATICK	29,496	30,645	30,743	32,600	35,299	38,277
NORTH BROOKFIELD	24,007	24,932	25,774	25,634	28,839	29,320
NORTH MIDDLESEX						
PALMER	24,359	25,130	25,915	26,695	27,492	27,330
PATHFINDER (VOCATIONAL)						
PENTUCKET						
PIONEER VALLEY						
PITTSFIELD	27,615	28,073	29,111	30,090	32,585	33,173
PROVINCETOWN	18,248	18,903	19,091	19,939	20,676	22,143
QUABOAG						
ROCKLAND	25,552	26,673	29,210	30,883	33,663	36,621
SALEM	24,905	27,437	28,999	30,058	31,112	31,628
SHAWSHEEN VALLEY (VOCATIONAL)						
SOUTHEASTERN (VOCATIONAL)						
SWAMPSCOTT	20,217	20,449	21,619	21,441	23,470	25,271
TRI COUNTY (VOCATIONAL)						
WEST SPRINGFIELD	22,529	22,999	24,181	25,054	25,850	26,870
WESTFORD	34,839	37,655	35,456	43,602	45,587	49,881
WESTWOOD	33,846	35,541	36,754	39,455	42,380	45,722
a1	93	94	95	96	97	98
AMHERST	30,571	31,549	31,372	33,843	34,018	35,191
AMHERST-PELHAM	30,571	31,549	31,372	33,843	34,018	35,191
ASHBURNHAM-WESTMINSTER						
ASHLAND	24,119	24,729	26,215	28,545	30,219	31,057

ASSABET VALLEY						
ATTLEBORO	25,611	26,305	27,073	27,835	$28,318	
BEDFORD	41,335	42,465	43,570	43,406	47,143	49,206
BELMONT	28,634	28,569	27,476	28,309	30,765	31,805
BERLIN-BOYLSTON	(22537+24,837)/2	(22712+25,228)/2	(22467+25,044)/2	(23126+28,230)/2	(23254+27,659)/2	(24832+28,914)/2
BEVERLY	28,945	28,307	28,870	30,578	32,680	34,549
BLACKSTONE VALLEY	21,166	22,468	22,483	24,309	25,153	26,203
BLUE HILLS VOCATIONAL						
BOSTON	37,550	38,337	40,552	42,806	45,204	47,868
BOYLSTON	24,837	25,228	25,044	28,230	27,659	28,914
BRAINTREE	29,504	30,030	30,129	30,879	31,929	33,532
BREWSTER	19,598	19,437	19,598	20,219	21,125	21,853
BRIDGEWATER	27,113	27,920	28,452	28,852	30,413	30,872
BRIMFIELD	19,207	20,131	21,361	23,328	24,597	24,047
BROCKTON	26,260	27,194	28,094	28,837	29,855	31,390
CAMBRIDGE	37,641	38,620	40,767	41,840	45,199	47,427
CARVER	20,705	21,540	21,005	23,423	22,787	23,790
CHELSEA	26,463	27,116	29,094	30,599	31,699	32,007
COHASSET	23,512	24,792	25,475	27,741	28,895	31,357
DIGHTON-REHOBOTH						
DOUGLAS	19,620	22,591	24,231	25,735	26,890	28,135
EVERETT	32,292	32,776	32,093	34,163	36,159	37,463
FALL RIVER	22,519	23,006	23,490	24,716	25,990	27,002
FALMOUTH	24,159	24,285	25,380	26,587	27,778	28,673
FITCHBURG	24,247	25,195	26,863	26,929	27,538	30,002
FOXBOROUGH	32,760	35,528	38,011	40,089	39,150	46,721
FRAMINGHAM	31,150	32,313	34,212	36,297	39,170	41,980
GATEWAY						
GILL-MONTAGUE						
GREATER FALL RIVER (VOCATIONAL)						
GREATER LOWELL (VOCATIONAL)						
GREATER NEW BEFORD (VOCATIONAL)						
HADLEY	15,867	16,049	16,578	17,394	17,067	17,862
HAMILTON WENHAM						
HARVARD	32,437	36,051	38,847	41,856	34,383	35,499
HARWICH	19,715	20,569	22,022	23,287	23,582	25,058
HATFIELD	27,007	24,766	26,134	28,704	30,690	31,887
HINGHAM	28,850	31,129	31,376	32,967	35,210	39,810
HOLBROOK	26,720	26,378	27,874	29,663	31,012	31,728
HOLLISTON	30,810	32,766	33,361	36,805	39,309	42,076
HULL	20,960	21,889	21,330	21,476	21,428	23,097
IPSWICH	25,860	26,725	28,075	28,806	29,967	30,273
KING PHILLIP						
LEE	26,897	26,314	28,846	27,774	28,560	29,044
LENOX	20,225	20,055	19,577	21,858	23,417	24,920
LEOMINSTER						
LEXINGTON	40,377	41,207	43,450	47,353	48,660	52,066
LONGMEADOW	20,372	21,031	21,740	21,881	22,854	24,094
LUDLOW	25,896	26,444	27,731	27,748	29,641	30,111
LYNN	30,130	30,674	30,815	31,946	33,055	34,026
LYNNFIELD	30,054	30,931	31,821	32,193	32,992	33,325

MALDEN	24,266	24,180	25,793	26,298	27,102	28,314
MANCHESTER	23,419	22,852	23,956	24,510	25,933	28,051
MARBLEHEAD	22,825	23,766	25,729	27,064	28,274	30,465
MASCONOMET						
MAYNARD	46,858	47,005	48,862	50,620	53,914	72,828
MEDFIELD	32,961	33,148	35,377	37,931	36,505	38,828
MEDFORD	27,466	29,554	29,749	31,350	33,158	34,647
MENDON-UPTON						
MILLIS	22,005	23,378	24,359	25,416	26,906	27,618
MILTON	25,406	26,312	28,194	27,857	28,587	28,750
MINUTE MAN (VOCATIONAL)						
MOHAWK TRIAL (SHELBURNE FALLS)0						
MOUNT GREYLOCK (WILLIAMSTOWN)						
NARRAGANSETT						
NASHOBA						
NASHOBA VALLY (VOCATIONAL)						
NAUSET						
NEW BEDFORD	24,039	24,513	25,324	26,182	28,008	28,676
NEWBURYPORT	23,854	24,868	26,476	27,835	29,082	30,078
NEWTON	31,762	33,194	34,520	35,555	36,925	40,787
NORTH ATTLEBOROUGH	21,077	20,976	21,603	22,680	23,757	24,154
NORTHAMPTON	22,245	23,111	24,146	24,994	25,660	26,743
NORTHEAST METRO (VOCATIONAL)						
NORTHERN BERKSHIRE (VOCATIONAL)						
NORWELL	29,002	29,247	30,241	31,650	34,941	39,927
OLD COLONY (VOCATIONAL)						
OXFORD	24,684	24,565	24,744	25,810	26,930	28,279
PEABODY	26,252	27,201	27,553	28,790	30,774	31,838
PLYMOUTH	26,345	26,627	27,805	28,755	29,894	31,061
QUINCY	28,258	29,858	31,029	34,212	35,044	37,317
RALPH C MAHAR						
SAUGUS	19,782	19,901	19,611	19,628	20,093	20,785
SEEKONK	20,190	19,367	20,099	20,580	20,957	22,208
SHARON	31,401	30,535	32,365	31,969	34,006	36,293
SOMERVILLE	23,867	24,491	24,087	25,090	25,686	27,729
SOUTH HADLEY	25,797	26,651	28,299	28,611	28,916	30,502
SOUTH MIDDLESEX (VOCATIONAL)						
SOUTHBRIDGE	23,998	24,616	25,978	27,677	27,305	28,023
SOUTHERN BERKSHIRE						
SPENCER	23,270	23,854	24,609	25,069	26,822	28,199
SPRINGFIELD	26,999	27,908	28,705	30,233	31,024	32,350
STOUGHTON	29,282	29,757	30,938	31,783	33,418	35,522
SUTTON	24,614	25,109	27,021	27,936	28,060	29,207
TEWKSBURY	33,088	34,153	36,343	37,717	41,158	42,403
TYNGSBOROUGH	23,649	24,498	26,056	24,248	25,488	26,732
UPPER CAPE COD (VOCATIONAL)						
WAKEFIELD	34,542	34,467	35,733	39,588	40,098	42,104
WALTHAM	36,408	37,521	40,180	44,547	47,392	52,130
WELLESLEY	36,690	38,106	39,304	41,427	44,850	47,756
WESTON	35,043	34,895	37,789	42,740	45,327	49,894
WHITTIER (VOCATIONAL)						

WILMINGTON	36,549	37,677	39,447	41,770	44,892	48,902
WINCHENDON	18,215	18,890	18,599	21,056	21,731	23,424
WOBURN	32,375	32,956	33,429	34,552	35,126	37,580
WORCESTER	27,547	28,388	28,623	31,198	32,178	33,545
WORCESTER TRADE (VOCATIONAL)						

Mean Combined Data Table

Town	1992	1993	1994	1995	1996	1997	1998	1999 current schedule
WARE				893		975	1022	952 4x4 - 1993
DENNIS-YARMOUTH				1007			1005	964 4x4 - 1994
CHATHAM				965	983	987	1010	1048 4x4 - 1995
GREENFIELD				1043			989	972 4x4 - 1995
HOPEDALE				1021	1060	1035	988	958 4x4 - 1995
TAUNTON				966	1052	932	992	931 4x4 - 1995
LEICESTER				938	933	979	981	949 4x4 - 1996
SANDWICH				1049		1068	1077	1050 4x4 - 1996
UXBRIDGE				955	1051	966	974	968 4x4 - 1996
WEBSTER				959	971	946	931	942 4x4 - 1996
WESTPORT				912	961	994	1022	1003 4x4 - 1996
CHELMSFORD				1061	1062	1062	1065	1072 4x4 - 1997
FRONTIER				1007			968	990 4x4 - 1997
GRANBY				996		970	1060	987 4x4 - 1997
HUDSON		1005		979	1011	939	977	957 4x4 - 1997
METHUEN				959	938	972	952	941 4x4 - 1997
NANTUCKET				995			1046	1013 4x4 - 1997
QUABBIN				1024			984	945 4x4 - 1997
WEST BOYLSTON				971	1007	966	975	1050 4x4 - 1997
WHITMAN-HANSON				1007		1028	1027	988 4x4 - 1997
AMESBURY				999	1025	1006	1020	921 4x4 - 1998
ANDOVER				1105		1098	1079	1107 4x4 - 1998
ATHOL-ROYALSTON				940			941	938 4x4 - 1998
AYER				947	1023	1023	962	890 4x4 - 1998
BRISTOL-PLYMOUTH VOCATIONAL				886			886	766 4x4 - 1998
DARTMOUTH				1002	1016	1002	1035	1027 4x4 - 1998
EAST LONGMEADOW				982			993	1015 4X4 - 1998
EASTHAMPTON				944		1001	998	965 4x4 - 1998
FAIRHAVEN				965	988	1005	958	987 4x4 - 1998
GROTON-DUNSTABLE				1066			1073	1045 4x4 - 1998
HAMPDEN WILBRAHAM				1066			1031	1035 4x4 - 1998
MILFORD				1012			1006	1021 4x4 - 1998
SOUTHWICK				968			944	970 4x4 - 1998
TANTASQUA				1032			1035	1010 4x4 - 1998
WINTHROP				975	993	960	938	971 4x4 - 1998
SOUTHERN WORCESTER COUNTY (BAY PATH)				847			833	670 4x4 AB - 1994
DUXBURY		1056		1072	1102	1095	1084	1093 4x4 AB - 1995
WEST BRIDGEWATER				954		949	938	922 4x4 AB - 1995
BOURNE				1027	1014	980	973	972 4x4 AB - 1996
LINCOLN-SUDBURY				1111	1120	1148	1149	1114 4x4 AB - 1996
NORTHBRIDGE				1006			992	975 4x4 AB - 1996
SILVER LAKE		1021		1039	1021	1012	1014	1027 4x4 AB - 1996
GRAFTON				1067	1052	1025	1069	1052 4x4 AB - 1997
MARSHFIELD		1018		1016	1007	1014	978	1014 4x4 AB - 1997
SCITUATE		1038		1045	1058	1024	1055	1033 4x4 AB - 1997
WAREHAM				938	913	920	895	876 4x4 AB - 1997

MARTHAS VINEYARD		983			999	997	4x4 AB - 1998
MIDDLEBOROUGH		974	975	998	1014	1021	4x4 AB - 1998
OLD ROCHESTER		1023			1027	1041	4x4 AB - 1998
STONEHAM		1010	1027	998	997	991	4x4 AB - 1998
NORTH READING		980	979	1016	1040	1061	4x4 AB - 1999
BARNSTABLE		1029	1027	1006	1055	1004	5 period - 1996
HOPKINTON	1055	1094	1082	1101	1101	1095	5 period - 1996
RANDOLPH	990	1001	980	971	978	957	5 period - 1997
DANVERS		957	1054	960	1003	968	5 period - 1998
NEEDHAM	1131	1103	1155	1131	1102	1115	5 period - 1998
NORTON	1060	1024	1028	1001	1000	1052	5 period - 1998
NORWOOD	1013	1022	1021	1039	1030	1005	5 period - 1998
WALPOLE	1047	1042	1036	1006	1058	1035	5 period - 1999
GEORGETOWN		1039		996	1004		Copernican - 1998
CLINTON		971	937	919	957	902	traditional - 1992
BERKSHIRE HILLS		993		1041	1026	1014	traditional - 1993
BELLINGHAM		981	1060	1022	989	994	traditional - 1994
ABINGTON	1008	1009	994	1027	996	993	traditional - 1995
AGAWAM		980	978	981	995	954	traditional - 1995
BELCHERTOWN		1020	1008	999	1031	966	traditional - 1995
BURLINGTON		1011	1018	1039	1029	991	traditional - 1995
CONCORD CARLISLE		1198	1134	1173	1057	1165	traditional - 1995
DRACUT		939	960	942	951	940	traditional - 1995
DUDLEY-CHARLTON		1006			1023	984	traditional - 1995
GARDNER		1058			1020	998	traditional - 1995
MARLBOROUGH		970	975	1011	978	1002	traditional - 1995
MEDWAY	1031	1033	1031	1080	1000	1058	traditional - 1995
MILLBURY		976	981	994	970	964	traditional - 1995
NORTH ANDOVER		1058	1045	1067	1042	1046	traditional - 1995
READING		1092	1067	1076	1054	1075	traditional - 1995
REVERE		901	891	871	869	859	traditional - 1995
ROCKPORT		987	1038	1019	1054	1005	traditional - 1995
SHREWSBURY	1006	991	1023	1032	1036		traditional - 1995
SOMERSET		1005	972	990	968		traditional - 1995
WATERTOWN	990	997	974	1032	972		traditional - 1995
WAYLAND		1165	1141	1176	1207		traditional - 1995
WESTFIELD		1047		1015	1045		traditional - 1995
WEYMOUTH	985	987	1024	968	978		traditional - 1995
WINCHESTER		1109		1129	1132		traditional - 1995
BLACKSTONE-MILLVILLE		975			988	976	traditional - 1996
FREETOWN-LAKEVILLE		998			996	927	traditional - 1996
SOUTH SHORE (VOCATIONAL)		873			908		traditional - 1996
BILLERICA		991	1041	1010	1044	1051	traditional - 1996 (6p)
BRIDGEWATER-RAYNHAM		1001		1022	1012	992	traditional - 1997
DEDHAM	1020	1028	1024	1043	1047	995	traditional - 1997
DOVER-SHERBORN		1134	1195	1146	1164	1164	traditional - 1997
EAST BRIDGEWATER		974	1043	1004	987	1009	traditional - 1997
MANSFIELD		1001	1038	1025	1036	1037	traditional - 1997
NORTH ADAMS		930		1009	954	954	traditional - 1997
NORTHBORO-SOUTHBORO	1093	1104	1107	1079	1094	1089	traditional - 1997
TRITON		988			1054		traditional - 1997

WESTBOROUGH	1172	1102	1089	1107	1113		traditional - 1997
MELROSE		1011	1024	962	1052	981	traditional - 1998
SWANSEA		981	1009	993	1000		traditional - 1998
ARLINGTON		1033	1022	1057	1074	1034	traditional - 1999
WACHUSETT		1051			1052		traditional - 1999
ACTON-BOXBOROUGH		1168	1146	1179	1173	1128	traditional - pre 1991
ADAMS-CHESIRE		1012		1028	1002	976	traditional - pre 1991
AUBURN		963	990	993	964	985	traditional - pre 1991
AVON	980	954	968	926	907	840	traditional - pre 1991
BROOKLINE		1095	1113	1133	1132	1078	traditional - pre 1991
CANTON	1071	1058		1056	1089	1037	traditional - pre 1991
CENTRAL BERKSHIRE		1042			1047	1011	traditional - pre 1991
CHICOPEE		957	996	993	987	932	traditional - pre 1991
EASTON	1055	1034	1058	1038	1026	1056	traditional - pre 1991
FRANKLIN	1045	997	1058	1028	1022	1000	traditional - pre 1991
GLOUCESTER		908	1020	975	960		traditional - pre 1991
GREATER LAWRENCE (VOCATIONAL)		770			734	538	traditional - pre 1991
HAMPSHIRE		1012			1073	1078	traditional - pre 1991
HANOVER	1053	1029	1045	1023	1035	1056	traditional - pre 1991
HAVERHILL		985	977	980	1007	975	traditional - pre 1991
HOLYOKE		906		945	944	903	traditional - pre 1991
LAWRENCE		738	763	748	745	636	Traditional - pre 1991
LITTLETON		992	1017	1072	1086	1041	traditional - pre 1991
LOWELL		877	921	912	915	888	traditional - pre 1991
LUNENBURG		1038	1020	1044	1045	998	traditional - pre 1991
MONSON		1001			1057	1003	traditional - pre 1991
MONTACHUSETT (VOCATIONAL)		871			930	742	traditional - pre 1991
NATICK	1057	1055	1083	1036	1046	995	Traditional - pre 1991
NORTH BROOKFIELD		994			1019	977	traditional - pre 1991
NORTH MIDDLESEX		1021			1057	1041	traditional - pre 1991
PALMER		953			1002	912	traditional - pre 1991
PATHFINDER (VOCATIONAL)		807			871	687	traditional - pre 1991
PENTUCKET		1089		1033	1041	1024	traditional - pre 1991
PIONEER VALLEY		962			947	1010	traditional - pre 1991
PITTSFIELD		1028	1025	1030	1027	994	traditional - pre 1991
PROVINCETOWN		942		955	904	892	traditional - pre 1991
QUABOAG		1006			1029	996	traditional - pre 1991
ROCKLAND		959	1026	1023	983	956	traditional - pre 1991
SALEM		929	926	921	937	851	traditional - pre 1991
SHAWSHEEN VALLEY (VOCATIONAL)		849			891		traditional - pre 1991
SOUTHEASTERN (VOCATIONAL)		804			799		traditional - pre 1991
SWAMPSCOTT		1086	1055	1048	1054		traditional - pre 1991
TRI COUNTY (VOCATIONAL)		902			951		traditional - pre 1991
WEST SPRINGFIELD		963			973		traditional - pre 1991
WESTFORD		1056	1089	1100	1093		traditional - pre 1991
WESTWOOD	1101	1059	1096	1120	1103		traditional - pre 1991
AMHERST			1097				
AMHERST-PELHAM		1112			1145		
ASHBURNHAM-WESTMINSTER		1051			1057		
ASHLAND	1058	981	1055	1069	1049		
ASSABET VALLEY		887			856		

ATTLEBORO		1003	967		948
BEDFORD		1106	1085	1065	1121
BELMONT		1126	1146	1137	1141
BERLIN-BOYLSTON		1024			986
BEVERLY		1000	1026	1020	1026
BLACKSTONE VALLEY		871			828
BLUE HILLS VOCATIONAL		841			879
BOSTON		830	860	845	843
BOYLSTON					
BRAINTREE	1023	988	1037	1026	1012
BREWSTER			1059		
BRIDGEWATER				1022	
BRIMFIELD			1041		
BROCKTON	908	908		892	891
CAMBRIDGE		942	919	935	931
CARVER	1015	950	1002	923	946
CHELSEA		809	752	753	776
COHASSET	1125	1113	1056	1047	1086
DIGHTON-REHOBOTH		1031			1031
DOUGLAS		890			1032
EVERETT		895	945	925	907
FALL RIVER		903	918	916	894
FALMOUTH		1002	1019	1023	1002
FITCHBURG		957			948
FOXBOROUGH		1007	1051	1032	1030
FRAMINGHAM	1055	1051	1059	1068	1078
GATEWAY		1011		992	1003
GILL-MONTAGUE		956			989
GREATER FALL RIVER (VOCATIONAL)		845			800
GREATER LOWELL (VOCATIONAL)		900			887
GREATER NEW BEFORD (VOCATIONAL)		762			771
HADLEY		1048		1043	1077
HAMILTON WENHAM		1074		1095	1050
HARVARD		1128	1125	1189	1140
HARWICH		988			1002
HATFIELD		1057		1035	945
HINGHAM	1114	1104	1077		1090
HOLBROOK	964	953	958	1074	991
HOLLISTON		1071	1087	1071	1084
HULL	950	913	952	911	887
IPSWICH		1048	1036	1048	1019
KING PHILLIP	1032	1048	1051	1071	1057
LEE		972		972	968
LENOX		1103	1108	1117	1063
LEOMINSTER		969			977
LEXINGTON		1175	1167	1172	1191
LONGMEADOW		1150		1151	1124
LUDLOW		930		937	1052
LYNN		859		885	884
LYNNFIELD		1086	1022	1073	1080
MALDEN		849		878	867

MANCHESTER		1063	1005	1065	1087
MARBLEHEAD		1035	1056	1062	1060
MASCONOMET		1079	1073	1085	1097
MAYNARD		1008		994	1010
MEDFIELD	1109	1139	1092	1237	1134
MEDFORD		925		978	939
MENDON-UPTON		997			985
MILLIS		1001		1023	1038
MILTON		1010		1002	1035
MINUTE MAN (VOCATIONAL)		906			874
MOHAWK TRIAL (SHELBURNE FALLS)0		1047			1053
MOUNT GREYLOCK (WILLIAMSTOWN)		1079		980	1087
NARRAGANSETT		1001			1022
NASHOBA		1089		1090	1068
NASHOBA VALLY (VOCATIONAL)		879			930
NAUSET		1055		1026	1008
NEW BEDFORD		909	921	928	937
NEWBURYPORT		1067	1045	1030	1076
NEWTON	1128	1162	1149	1165	1178
NORTH ATTLEBOROUGH		1007	1032	1035	1008
NORTHAMPTON		1053		1060	1040
NORTHEAST METRO (VOCATIONAL)0		824			789
NORTHERN BERKSHIRE (VOCATIONAL)		853			917
NORWELL		1054		1074	1080
OLD COLONY (VOCATIONAL)		901			872
OXFORD		913	1022	920	949
PEABODY		963	976		960
PLYMOUTH	1008	1029	1006	1011	1015
QUINCY	972	928		970	948
RALPH C MAHAR		1004			1026
SAUGUS		956	975	964	970
SEEKONK		982	998	1015	1015
SHARON		1123	1103	1123	1107
SOMERVILLE		899	885	860	899
SOUTH HADLEY		1038	1044	1019	1040
SOUTH MIDDLESEX (VOCATIONAL)		833			921
SOUTHBRIDGE		960	955	934	989
SOUTHERN BERKSHIRE		974			1026
SPENCER		998			958
SPRINGFIELD		875			877
STOUGHTON		1011		991	1028
SUTTON		998	1037	976	997
TEWKSBURY		962	997	1058	1002
TYNGSBOROUGH		968	995	971	1004
UPPER CAPE COD (VOCATIONAL)		882			874
WAKEFIELD		1033	1032	1021	1046
WALTHAM		954	955	970	956
WELLESLEY	1139	1177	1148	1133	1138
WESTON	1138	1158		1196	1192
WHITTIER (VOCATIONAL)		810			852
WILMINGTON		1015	978	993	1002

WINCHENDON	1007	986	932	994
WOBURN	1002		1001	1000
WORCESTER	897	923	874	893
WORCESTER TRADE (VOCATIONAL)	754			816

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http://www.ed.gov/

North Carolina Public Schools Info Web
http://www.dpi.state.nc.us/block_scheduling/

The Lindsay Report on Block Scheduling
http://www.athenet.net/~jlindsay/Block.shtml

The Massachusetts News Web Site
http://www.massnews.com/

The Center for Education Reform
http://207.86.17.180/

Information on block scheduling at the Longwood College Web Site
http://web.lwc.edu/staff/fmoore/BL/index.htm

A Citizens Guide to Education Reform
http://www.schoolchoices.org/

Info on schedules at The American Association of School Administrators web site
http://www.aasa.org/SA/may9803.htm

Education Week on the Web
http://www.edweek.org/sreports/qc97/

Information on block scheduling at the University of Minnesota web site
http://www.coled.umn.edu/CAREIwww/blockscheduling/resource.htm

The 1995 British Columbia Assessment of Mathematics and Science
http://www.bced.gov.bc.ca/assessment/masc95/contents.htm

Information on some block scheduling studies at the Drexel University web site
http://www.sciences.drexel.edu/block/canadianstudy/canadianstudy.html