

AN EVALUATION OF A PROGRAM OFFERING EXTRA
TIME TO HELP STUDENTS ACHIEVE SUCCESS
WITH ACADEMIC MATHEMATICS

CENTRE FOR NEWFOUNDLAND STUDIES

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GERALDINE MARY KAVANAGH, B.Sc., B.Ed.



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TIME TO HELP STUDENTS ACHIEVE SUCCESS
WITH ACADEMIC MATHEMATICS

by

©Geraldine Mary Kavanagh, B.Sc., B.Ed.

A thesis submitted in partial fulfilment
of the requirements for the
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Department of Curriculum and Instruction
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Abstract

The primary purpose of this study was to evaluate a program offering extra time to certain students who have a demonstrated difficulty with academic mathematics. The intention of this program is to help these students achieve success with academic mathematics. As a consequence, it is hoped that the attitude of these students toward mathematics would improve if their achievement improved.

To evaluate this program, several different methods were undertaken. All eight classes given the extra time were given an attitude survey twice as a pretest and posttest to see if any change in attitude towards mathematics took place. As well, the end of year marks were obtained for this group of students and a comparable group who studied the same courses but who did not receive the extra time. In addition, both of these groups were given a 25 item test developed by the researcher. Interviews were conducted with the seven teachers involved with the teaching of the classes that had received the extra time. Finally, a videotape was made of two of the eight classes to obtain information on how the extra time was used.

The data collected with the attitude surveys was tested using t-tests. The test scores for the two comparable groups was compared using a two-way Analysis of Variance (ANOVA). As well, a great deal of qualitative data was collected on the

group receiving extra time and this was also reported on.

This study focused on two questions, one dealing with the achievement of the group and one dealing with their attitudes towards mathematics. The results indicate a very slight increase in the achievement of these students on the final evaluation. There was no significant difference on the 25 item test. There was also no significant change in the attitude of these students after they received the extra time studying mathematics.

Based on the findings of this study, the researcher concluded that evaluating a program is indeed a difficult task. After spending a great deal of time on this evaluation, I was unable to ascertain whether the program was successful or not. It was recommended that a much more controlled experiment would be necessary to evaluate this type of program.

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CHAPTER I

Introduction

Rationale for the Study

During the last few decades, much attention has been given to research on learning and achievement as it relates to time allotments and time utilization. Educators such as Bloom (1976, 1981), Carroll (1963), Gettinger (1979, 1985); Harnischfeger (1976), Wiley (1974), and others have come to believe that allocating extra instructional time to students will result in achievement gains. Accordingly, since 1986 several schools under the jurisdiction of the Roman Catholic School Board for St. John's have allocated extra time to some lower ability students in an effort to help these same students experience greater success with academic mathematics. The study reported here was developed to evaluate this practice. This evaluation would provide information about the effectiveness of this approach which might lead to suggestions for the improvement of the program.

Prior to 1982, Newfoundland and Labrador high school students completed their high school mathematics program over a two year period. Mathematics was taught by using nine or ten 40-minute classes during a five or six day cycle. This program provided approximately 60 minutes of instruction per day to mathematics over a six day cycle. In the reorganized high school program which began in 1982, mathematics courses are

taught with six 40-minute classes over a six day cycle for three years. As a consequence, this program provides approximately the same total amount of time as in the past or can even result in a slight loss of total time. (See Table 1).

Table 1

Time Allocated to Mathematics in Newfoundland Schools Prior to 1982 and Since 1982

Time Allotted for Mathematics Prior to 1982	$165 \text{ days} \times 60 \text{ minutes/day} =$ $9900 \text{ minutes/year}$ $9900 \text{ minutes/year} \times 2 \text{ years} =$ $19800 \text{ minutes over 2 years}$
Time Allotted for Mathematics Since 1982	$165 \text{ days} \times 40 \text{ minutes/day} =$ $6600 \text{ minutes/year}$ $6600 \text{ minutes/year} \times 3 \text{ years} =$ $19800 \text{ minutes over 3 years}$

This researcher derived the 165 days a year based on the 190 teaching days approved by the government of Newfoundland and Labrador. I deducted the three paid holidays, two days for administrative purposes and 20 days for two sets of formal examinations. The 165 days do not take into account lost time due to storm days, assemblies, and so on. Consequently, mathematics did not gain any extra instructional time over the three year period when the reorganized high school program was

introduced. The time allotted to mathematics is now spread out over three years.

Usually students who enter high school with a poor mathematics background have difficulty with high school academic mathematics. This may be a result of a lack of understanding of the prerequisite skills or a lack of effort, or as a result of a combination of factors. However as Stallings (1980), points out: "Even though high-achieving students are more inclined to be engaged in academic tasks, it is of considerable importance to allocate sufficient time and effort to working with low-achieving students who may not be so inclined" (pp. 11-12).

In their curriculum guides for mathematics, the Department of Education for Newfoundland and Labrador maintain that "the mathematics programs ... are designed to provide all students with a sound background in the basic mathematical skills necessary ... to function in contemporary society, and for use in the future" (p. 1). The curriculum guides also assert that the mathematics programs "recognize the individual needs and abilities of students and provide a system by which the general objectives may be met in different ways for different students" (p. 2). The philosophy expressed in the above statements seems to claim that the mathematics courses of the province are able to meet the needs of "all" learners. Even so, some students still experience difficulty, which may be due to time restraints on their mathematics learning.

A recent Task Force on Mathematics and Science Education (1989) in Newfoundland and Labrador felt that "students of different aptitudes will require different amounts of time to learn" (p. 220). The Task Force also suggests that mathematics and science are the "subjects which present substantial difficulties for students, then a clear case exists for allocating as much time as necessary to these subjects to ensure that students succeed" (p. 217). This would imply using differential amounts of time for different students in order to help all students experience success with mathematics. One way to receive this extra time, the Task Force claims, would be to use the additional time that is currently used for elective subjects in the curriculum (such as typing, physical education, art) for basic academic areas such as mathematics and science.

During the school year 1986-1987, the Roman Catholic School Board for St. John's decided to offer academic mathematics to some lower ability students for nine 40-minute classes during the six-day cycle. This would entail the loss of a one credit course such as typing, business education, or music. This decision was taken in an effort to help these same students experience success with mathematics. The students studied the same academic course as other students (ages 15 and 16) in Level I mathematics. By taking nine classes to study mathematics, rather than the six recommended by the government curriculum guides, these students would be complet-

ing only 13 credits a year as compared to the 14 credits also recommended by the Department of Education. Nonetheless, if they were successful in completing these 13 credits a year, they would still be able to meet the graduation requirements. This method of obtaining extra time would appear to be similar to the one suggested by the Task Force on Mathematics and Science.

This approach was begun in one high school in the board. Since the first year appeared to have been a successful one, the practice of using nine classes instead of the regular six for academic mathematics was gradually increased throughout schools under the jurisdiction of the Roman Catholic School Board for St. John's. Thus, during the school year 1988-1989, there were eight classes (128 students) receiving this extra time. By this time, it became apparent that a need existed to evaluate the practice of increasing allocated instructional time as it related to the achievement and attitude of these high school students.

The Purpose of the Study

The purpose of this study was to evaluate the effectiveness of a particular method of allocating extra time to help lower ability students achieve in academic mathematics. This evaluation was carried out to determine if the program was effective. That is, this study attempted to determine if the method of allocating extra time to lower ability students

accomplished its purpose. More specifically, the following questions were investigated:

1. Are these students experiencing success with academic mathematics?

2. Will the attitude towards mathematics on the part of students who are receiving more time at mathematics change during the year of schooling?

In addition, by comparing the achievement of these students with students of similar ability who did not receive the extra time, the researcher attempted to determine if the goals of the program are being met. The groups were made comparable according to scores received on the Canadian Achievement Test in Mathematics.

This study could be considered as "action research." In the words of Borg (1987), "the goal of action research is to gather evidence that can help the teacher or administrator make decisions related to the local schools" (p. 284). One of the goals of this study has been to assist the school board in making future decisions about continuing this program to assist some of its students.

Significance of the Study

Most of the available research on time and achievement has been focused on instruction with primary, elementary and junior high students. There appears to be less research available on the relationship of allocating instructional time

to achievement in mathematics among high school students. This is especially true for Newfoundland and Labrador schools. Even so, most of the available research on time does involve the basic subject areas of mathematics, reading and language arts. High school is different from primary and elementary schools in that high schools usually allocate fixed time class periods and subject teachers to the various subjects. As a consequence, the ability of a high school teacher to allocate extra time to mathematics or any other subject is restricted during the normal school day. By contrast, at the primary or elementary levels, students are usually taught all subjects by the same teacher. Therefore, the teacher is able to allocate extra time to any subject or topic if he or she feels it is needed. Depending on the size of the school, junior high school teachers may or may not be able to allocate extra time. Some junior high schools are similar to high schools whereas other schools function much like the elementary schools.

The Task Force on Mathematics and Science Education (1989), has recommended:

... that school schedules and student programs be designed to allow for differential time allocations in basic subject areas. This should be accomplished by having students who need more time take fewer optional courses, particularly at the intermediate and senior high school levels. (Recommendation 10.12, p. 223)

Since this is the approach already begun by the school board, this study may be useful in determining if such a recommendation can be accomplished successfully in this particular venue.

Constraints on the Study

The following can be considered as constraints on the study:

1. All students involved in the study came from one school board within the province.
2. The sample of those students who received extra time was limited to 128 students from the eight classes within the board's jurisdiction who received the extra time.
3. The researcher had no control over assignment to classes. Intact classes had been previously assigned by the various high schools involved in the program.
4. The June examination mark in mathematics which served as one indication of achievement was based on different evaluations within the five high schools offering the extra time for mathematics.
5. The researcher had no control over the assignment of teachers to the various classes.
6. The researcher had no control over the class size or the method by which the extra time was allocated. Five of the eight classes involved were intact classes for the nine periods, whereas three classes had intact classes for six

periods with a smaller number of the class allocated the extra three periods.

CHAPTER II

A Review of Related Literature

Introduction

This study attempted to evaluate a program of allocating extra time in order to help lower ability students to experience success in academic mathematics. In conjunction with this effort, a review of the literature was undertaken to determine the relationship between time and achievement especially as it relates to high school mathematics.

Chapter II is divided into five sections. Section one contains a review of theories that link time to achievement. Section two relates research studies that show a relationship between allocated instructional time and achievement. Studies which show a relationship between time and a student's ability to learn are presented in section three. Section four relates studies involving mathematics achievement specifically to time. The attitude of students as related to achievement is discussed in section five.

Time: Theories and Models

The Carroll (1963) model.

Several models were found which linked time and school achievement, one of which was proposed by Carroll (1963). His work led to much further interest in time as a significant variable for school learning. His "Model of School Learning"

incorporates time with five other variables.

1. Aptitude--the amount of time a student would need to learn a task with optimal instructional conditions.
2. Ability to understand instruction.
3. Quality of instruction--the degree to which the teacher or instructional resources organize and present the task in order that the learner can learn it as rapidly and efficiently as possible.
4. Time allowed for learning--the opportunity to learn.
5. Perseverance--the amount of time that the learner is willing to spend in learning a task or concept.

Carroll (1963) recognized that the first three variables are determinants of time needed for learning whereas the last two mentioned are determinants of the time actually spent in learning. He worked the five variables into a mathematical formula:

$$\text{degree of learning} = f \left(\frac{\text{time actually spent}}{\text{time needed}} \right)$$

This is not the traditional meaning mathematicians have placed on functions, but it helped Carroll explain his point.

Carroll (1963) considered the factors aptitude, ability to understand instruction, and perseverance as being variables internal to the learner; whereas, quality of instruction and opportunity to learn are external conditions. He conceded that the quality of instruction is an "elusive" quantity while the time to learn is under the control of the teacher.

This study did not focus on aptitude as defined by Carroll (1963), or perseverance of the students. However, students were selected for this program based on their presumed ability to learn mathematics. The time allowed for learning is the variable selected for comparison between the groups.

The Bloom (1976) model.

Bloom (1963) based his model on the work of Carroll (1963). He transformed Carroll's conceptual model into an instructional model known as the "mastery learning model." He felt that if Carroll were correct then it would be possible to assist all learners to reach high levels of achievement, by increasing the time spent until it approached the time needed to learn a concept. The main goal of mastery learning is to manipulate learning variables to enable 95% of the learners to reach mastery on a particular task.

Bloom's (1976) mastery learning model is based on three major factors. Bloom stated that these three factors are:

1. Student characteristics: cognitive entry behaviors--the basic prerequisite learning skills that are necessary for the new learning task; and affective entry characteristics--the motivation that the student has or can be motivated to learn a task.
2. Instruction: the cues, practice and reinforcement given during the learning process that help meet the needs of

the learners.

3. Learning Outcomes: level and type of achievement, rate of learning, and affective outcomes.

Bloom (1976) felt if the student entry characteristics and the quality of instruction are fitting then the learning outcomes will be positive. He assumed that the entry characteristics of the learner and the quality of instruction can be modified to obtain a higher level of learning. He emphasized that increasing allocated time in itself is not the most efficient way to improve achievement. All students are different and each one brings different characteristics to the learning situation that determines how efficiently he/she will use the time allocated to him. This change in thinking (whereby it was felt that all learners could reach a high level of achievement if given enough time) led to newer models which placed more emphasis on how allocated time can be used effectively.

In an analysis of 27 mastery-learning studies, Guskey and Gates (1986) found that mastery-learning can result in positive gains in achievement. In passing, they found the effects were greater at the elementary and junior high levels than at the senior high level and that effects in language arts and social studies were slightly higher than those in mathematics and science studies.

While Bloom (1976) conceded that increased allocated time of itself is not the most efficient way to improve achieve-

ment, the main focus of this present study concentrates on increases in allocated time and how achievement may be affected by this increase. It must be stressed that the researcher had no control over the students selected for inclusion in this program nor any input into the kind of instruction they were given.

The Wiley-Harnischfeger (1974) model.

The Wiley-Harnischfeger (1974) model also considers time to be a basic ingredient for achievement. They claim that achievement is determined by two variables: (a) the total time needed by a given pupil to learn a task, and (b) the total time the pupil actually spends on this task. These variables are similar to Carroll's (1963) model. However, they claim that there can be enormous variations in the total allocated time.

Their model distinguishes between different types of classroom events and suggests different measures for instructional time. They distinguish between the teacher's on-task time and the students' on-task time. Further, their model shows how pupil and teacher use of time interact to influence achievement.

Wiley and Harnischfeger (1974) also saw achievement as a function of time but their mathematical formula was a refinement of Carroll's (1963). To them:

$$\text{achievement} = f \left(\frac{WXY}{Z} \right)$$

where: W = total allocated exposure time
X = percent active learning time
Y = percent usable exposure time
Z = total needed learning time.

It must be noted that this researcher was able to study the total allocated time of the two groups being compared. The total needed time to learn a concept would be a very elusive time to determine and would certainly vary from student to student.

The Bennett (1978) model.

A model proposed by Bennett (1978) is considered a modification of the Wiley-Harnischfeger (1974) model. He distinguishes between the nominal amount of time in school (actual length of the school day and the school year) and the actual amount of time used in school where extra holidays, building alterations, and so forth are excluded. He further subdivides the time available to learning by considering the time allocated to each area of the curriculum such as mathematics, English, science, art, and so on. By deleting the disruptions and lack of interest or poor persistence of the student, the total active learning time can be determined.

According to Bennett (1978), only "the active portion of the time assigned to a task is effective for learning that task" (p. 128). He felt that aptitude and prior achievement, clarity of instructions, task difficulty and pacing of the

instruction were important to current achievement. Therefore, he concluded that only the time in which a student is actually comprehending a task is considered effective for acquiring that task. This should determine the total content comprehended and have a bearing on the actual achievement. He also felt that feedback is an important characteristic that influences comprehension and achievement.

While agreeing with Bennett (1978) that active learning time is the most effective, this researcher would have been unable to ascertain this time for the group under study if indeed it could have been done. In addition, Bennett also contends that aptitude, prior achievement and pacing of instruction are important for achievement. The students selected to receive the extra time in mathematics have a record of poor prior achievement in mathematics. If giving extra time enables the teacher to slow the pace of instruction, then indeed their achievement may be affected.

The ALT model.

The Beginning Teacher Evaluation Study (BTES), (1980) outlined by Denham and Lieberman (1980), was carried out by the Far West Laboratories in California to identify teaching activities and other classroom conditions that would foster learning. The study focused on reading and mathematics instruction at the grade two and grade five levels.

From this study, the concept of academic learning time

(ALT) was developed. The ALT model is based on:

1. Allocated time.
2. Student engagement: time in which a student is actively engaged in the task.
3. Success rate: the degree to which a student processes, understands and correctly responds to a learning task. High, medium, and low success rates were determined.
4. Task relevance: the learning activities of the student must be limited to the content categories that are to be covered on the measure of achievement.

In addition, the BTES (1980) investigators identified two phases of the instructional process that they felt would result in increases of the ALT. These are the "planning" phase and the "interaction" phase. The planning phase includes:

1. Diagnosis: assessing the previous knowledge, skills, strengths and weaknesses of the student.
2. Prescription: deciding on the appropriate goals, activities, groupings and schedules.

The interaction phase involves:

1. Presentation: teacher actually presents task or concept to the students.
2. Monitoring: teacher is able to determine the student's state of knowledge and skill during task.
3. Feedback: based on the monitoring of students, teacher determines whether additional information or explanation is needed.

Again, this present study was designed to concentrate on allocated time, with success being determined by a passing grade (a mark greater or equal to 50%) on the June report card.

Five theories or models were selected for inclusion in this review of the literature, because all five focus to some extent on "allocated time", which is the main focus of this present study. Finally, since all of the models identified here also involve other factors which this researcher had little or no control over, no particular model was selected as a specific model to follow for this study.

Allocated Instructional Time

Allocated instructional time can be defined as the amount of time that a teacher has been assigned to teach a course. In Newfoundland and Labrador, the Department of Education is responsible for deciding the number of days in a school year and the number of hours in a school day, as well as the amount of time to be allocated to a particular subject. At the primary and elementary level, teachers have some freedom within the school day to allocate the amounts of time that they will use for each subject area. At the secondary level, the teachers have little freedom because the government specifies in its Senior High School Certification Handbook (1985) that all two credit courses require 110-120 hours of instruction per year. Since all academic mathematics courses

are two credit courses, no extra time can be obtained during the school day unless there was a change in the high school program.

The allocated time recommended by the Department of Education is the upper limit. Actually, and often for a number of reasons, the amount of time used for instruction would be less than the 110-120 hours recommended. The Task Force on Mathematics and Science (1989) found that the time actually used is consistently less than that allocated. This was true at all levels. The Task Force found widespread variation in time actually allocated to mathematics and science in elementary schools. A number of other researchers (Crocker, undated; Gettinger, 1984; Powell, 1979; Romberg & Carpenter, 1986; Sanford & Evertson, 1983; Walberg, 1988) have also found that allocated time varies from school to school and even from classroom to classroom in the same school. As the authors suggest, a loss of allocated time is a problem not only in Newfoundland and Labrador but in other provinces and states as well. In a study by Duke (1978, as cited in Fredrick & Walberg, 1980), high school administrators rank skipping class, truancy and lateness as the top three causes of instructional time lost. Other factors accounting for time lost in high school include examinations, assemblies, storms, furnace problems, teacher strikes, and so on. As a result of the great deal of time that is lost in school, Wyne and Stuck (1982) have distinguished between located time and instruction

time. They defined instruction time as "the proportion of time allocated for academic activities that is actually devoted to instruction" (p. 68).

The researchers of the BTES (1980) study found a positive relationship between allocated time and student achievement in mathematics and reading in grades two and five. As Fisher et al. (1980) reported on the findings of the study; "Teachers who allocate more time to a particular content area of the curriculum have students who achieve at higher levels than teachers who allocate less time to that content area" (p. 15). They concluded as a major finding of the BTES Study that the amount of time allocated to a particular curriculum area was positively associated with student learning in that area.

Even so, not all researchers are convinced of the effects of increased time on achievement. Borg (1980), in a further analysis of the data relating achievement to allocated time, found "most of the significant relationships between achievement and allocated time are not large, accounting for from three to six percent of the residual achievement variance" (p. 60). Fredrick and Walberg (1980) claim "time devoted to school learning appears to be a modest predictor of achievement" (p. 193). Dempster (1987) appears to agree with this and claims that an increase in allocated time will have no impact on learning unless it is accompanied by an increase of time on task or engaged time. Wyne and Stuck (1982) felt that even though allocated time has an effect on achievement, "it is not

simply the total quantity of time spent that has the greatest impact on student achievement, but the quality of the quantity of time spent learning" (p. 71). Blai (1986) goes so far as to claim that extending allocated time may even be detrimental to learning. This could be because of fatigue occasioned as a result of the additional time spent. Blai further claims that: "If students choose not to put much effort into their studies, or choose not to concentrate on their studies, the amount learned through the simplistic mechanism of additional allocation could either be wasted or prove counterproductive" (p. 40).

In a study of 102 junior high English and mathematics classes, Sanford and Evertson (1983) reported that there was a significant relationship between time use and achievement in the mathematics classes but not in the English classes. For mathematics classes, "higher mean class achievement gains were related to more time spent in whole-class instruction ($r = 0.4252$) and less time spent in seatwork ($r = -0.4160$)" (p. 166). The r refers to the Pearson r and the findings were significant at $p < .05$ level. These findings appear to indicate that how time is used makes a difference in achievement gains. The researchers felt that the subject matter was important in studying effective teaching and time utilization. They found that in the English classes, there was a wide variety of instructional approaches and curriculum content. This made for a high degree of incongruence between what was taught in

classes during the year and the end of the year achievement measure. Sanford and Evertson did not find the same incongruence in the mathematics classes.

In a study of allocated instructional time and achievement in high school economics, Poindexter (1985) compared 88 high school students who received 73 hours of instruction with 89 adult high school students who received 60 hours of instruction to study the same economics course with the same teacher. Both groups of students were administered a standardized Test of Economic Literacy (Form A for the pretest and Form B for the posttest). She found that "the achievement gain of adult high school students with 60 hours of allocated instruction was equal to the achievement of regular high school allocated 13 additional instructional hours" (p. 78). She felt that factors other than allocated time could have had an impact on the achievement of students in economics.

A study on the teaching of Basic Reading Skills in secondary schools reported by Stallings (1980), found that student reading gains can be achieved by allocating time to specific reading activities and that the distribution of time can affect reading levels. The findings of the study suggest that spending more time on discussion and review results in more student gain in reading.

A study by Schmidt (1978, as cited in Borg, 1980) determined the effect of the quantity of schooling during high school on achievement in six subject areas. His data was drawn

from a national longitudinal study of 9192 high school seniors in 725 schools. Six areas of the curriculum were examined: mathematics, English, foreign language, fine arts, social studies and science. The study by Schmidt found that the quantity of schooling received had the greatest effect on achievement in mathematics, science and English. Mathematics was determined to be almost entirely learned in school and of the six areas studied, mathematics was the most strongly influenced by potential quantity of schooling. This finding contradicts the findings of Guskey and Gates (1986). According to Borg (1980), "the results of Schmidt's work demonstrate that the quantity of schooling a student receives in high school does have a significant effect on academic achievement" (p. 49).

Despite the fact that several researchers have found that allocated time increases had little or no effect on achievement, most researchers hold sacred the view that the time allocated for learning or the quantity of instruction is still a significant variable affecting achievement (Gettinger, 1985; Harnischfeger & Wiley, 1976; Karweit, 1976; Stallings, 1980). According to Husen (1972), if an adequate amount of time is not provided or students do not spend a sufficient amount of time engaged in learning then the degree of learning will be lowered.

Time and Ability to Learn

Allocated time can be lost during the school year for many reasons. Time is lost because of storms, furnace problems, assemblies, fun days, and examinations, to name just a few. This loss of time apparently has an effect on student performance. However, the more able students appear to be able to complete successfully the mathematics courses. But slower students who are at a disadvantage when they enter high school may need the extra time to be successful with the academic mathematics courses. Not all students learn at the same rate. This was one of the main reasons why the school board initiated this program for the slower students. It was hoped that the extra time would help these same students experience success with an academic mathematics program.

At the high school level, most subject areas have been allocated a specific amount of time to cover a required course of study. Anderson (1981) refers to the use of class periods as a fixed-time condition. However, he points out that "by operating under fixed-time conditions, ... we are guaranteeing that some students will learn a great deal, some will learn moderately well, and some will not learn at all" (p. 1). In Newfoundland and Labrador, the Department of Education specifies that all two-credit courses at the high school level are to be allocated one class period per day. This may be enough time for some students but it may be insufficient for many others.

The time needed to learn a concept can vary greatly from one student to another. Deciding just how much time is required to learn a concept is a question which is at the center of the research on time and learning. According to Walberg (1988), answering this question depends on "what is to be learned, how it is taught, and the student's aptitude" (p. 83). Gettinger (1984), in an extensive review of literature to determine the individual differences of students and the time needed for learning, provided some interesting estimates. For example, she quoted a study in which the fastest students completed 5000 reading problems over a seven month period using a computer assisted program whereas the slowest students completed only 1000. Gettinger feels that "students do differ in the rate at which they learn school-related tasks" (p. 23). She quotes many studies to support this claim in which variations in learning time for slow and fast learners vary from 1.5:1 in one study to a high of 7:1 in another study.

Fredrick and Walberg (1980) report that Bloom (1976) "estimates that the slowest 10 percent of students may need five-to-six times as much time to learn as the most rapid 10 percent, but they are usually not given it" (p. 191). Guskey and Gates (1986), in their synthesis of the effects of mastery learning, also found studies in which the amount of time needed to learn varied among fast and slow learners. It was earlier noted that Bloom proposed that by using his "mastery learning" model, all learners could reach a high level of

achievement if allocated enough time. However, Fuchs and Fuchs (1986) found that mastery learning actually retarded the success of high achievers in grade one. They felt that too much allocated time could slow their progress. They concluded that the low achievers required more direct, structured, and elaborated instruction.

Mastery learning techniques can decrease the differences between fast and slow learners, according to Arlin (1984). Gettinger and White (1979) found that the time needed to learn was more likely correlated to school achievement than was the IQ score of grade four, five and six students. Arlin (1984) agrees that differences in learning abilities are reflected in individual differences in the amount of time needed to learn material. One way to decrease this gap between students is to provide extra time especially in areas where specific prerequisites are required before proceeding to the next step. Academic mathematics in the secondary school would certainly be a subject requiring prerequisite skills.

A study by Gettinger (1985) attempted to evaluate the extent to which allocating less time than the amount needed would affect the overall achievement of school related material. The study involved 171 fourth and fifth grade students. The time needed for learning was based on the number of trials needed to master a task in reading to 100% accuracy. The time allocated for learning was reduced systematically for all children. The study found that allocating insufficient

learning time had a negative effect on achievement. According to Gettinger (1985), "the most obvious implication from these findings is that spending less time than needed or allocating less time than needed does affect student achievement" (p. 10). This implies that slow learners may not be able to learn the same amount of material in the time assigned to the faster learners. As a consequence, allocating extra time to slow learners may be one way to help them achieve success with mathematics.

Reporting on a study entitled National Follow Through Observation Study 1975, Stallings (1980) reported that low achievers in grade three achieved more in mathematics and reading than higher achievers when they were given an increase in time. In a large two-phase study involving 87 remedial secondary classrooms, Stallings found that increasing allocated time to improve reading resulted in positive gains if the teacher used an interactive on-task approach to instruction, but a slight or negative gain was obtained if the teacher allocated the extra time to noninteractive instruction. She found that when the teachers were supportive and gave positive feedback, the students improved in reading achievement. She claimed that "low-achieving secondary students ... prospered more and seemed to need this nurturing environment more than did those secondary students who were achieving at a higher level" (p. 13).

Karweit and Slavin (1981) studied 18 primary and elemen-

tary classrooms in rural Maryland to see how time affected achievement gained. They investigated four measures; total scheduled time, total instructional time, total engaged time and engaged rate. They defined "engaged rate" as the total engaged time divided by the total instructional time. They found the strongest relationship with achievement occurred when the time measures captured the individual's engaged time. Their results also indicated that different students will experience different effects of time depending on their position relative to the class average. Above average students will need less time to master the material, whereas students below the average may need more time.

In summary, from the evidence of the studies on ability, it would appear that the idea of allocating extra time to high school students with lower ability in mathematics could certainly be seen as a positive step toward helping these students.

Time and Mathematics

In this section, studies involving time as it relates to achievement in mathematics were investigated. Very few studies could be found concerning allocated time and mathematics, especially at the high school level. According to Robitaille (1975) and Karweit (1984), there is a need for research in this area.

Walberg (1988) argues that mathematics and science "...

because of their highly specialized and abstract symbolism, may require the greatest concentration and perseverance" (p. 76). Welch, Anderson and Harris (1982), claim that subjects (such as mathematics and foreign languages) that can only be learned in school will show stronger effects from time in school than is true for other subjects. According to Romberg and Carpenter (1986), the research on time and mathematics achievement clearly supports the fact: "While there are limits on the amount of time any class teacher can allocate to mathematics instruction, the teacher who consistently devotes less time to mathematics instruction than colleagues can expect relatively poorer student achievement" (p. 862).

Husen (1967) was the chairman of a very large comparative study undertaken by an international project for the evaluation of educational achievement (IEA). The study was a large cooperative cross-national educational research project involving 12 countries. The study involved 13-year-old students and pre-university students. Many variables were investigated, but for the purposes of this study the variables of importance were: (A) total hours per week in school; and (b) the hours per week allocated to mathematics teaching. The study found that the percentage of time per week devoted to mathematics varied from 11% to 18% among the countries studied. According to Husen (1967), "the number of hours per week of schooling seemed to bear little or no relationship to mathematics achievement, while total homework at the lower

level and mathematics homework at the pre-university level seemed to be of greater importance" (pp. 301).

Lindsey (1974), in a follow-up analysis of the IEA study, attempted to study the relationship between achievement in mathematics to class size and to the number of hours of mathematics instruction received each week. He based his study on the mean score in a classroom and not on the scores of individual students. He found that as the class size increased, there was a distinct drop in the mean score for all classes, except for those that received the largest number of hours of instruction. He felt that one cannot conclude that there is an optimum amount of instruction which would increase achievement if given to all students.

The extensive BTES (1980) study produced many results involving allocated time and achievement, as well as ALT and achievement. These findings are relevant to mathematics at the grade two and five levels. According to Fisher et al. (1980), 14 major findings were discovered relating time and achievement. The ones relevant to this study include:

1. "The amount of time that teachers allocate to instruction in a particular curriculum content area is positively associated with student learning in that content area-" (p. 15)

2. "The proportion of allocated time that students are engaged is positively associated with learning" (p. 16). Although these results relate to mathematics at the grades two

and five levels, it seems conceivable that they would also have significance at the high school level.

The findings of the BTES (1980) study are also confirmed by Borg (1980) and Anderson (1981). In addition, Brown and Saks (1984), who analyzed the BTES findings, claim that mathematics achievement in grade two could be increased by 2.5% if allocated time were increased by 10%. They suggest that there would be a less modest gain in grade five. If the increase in achievement decreases with grade level, then perhaps the gains at the secondary level would be minimum. But this remains to be investigated.

A study by Fitzgibbon and Clark (1982) examined the use of time in eight secondary mathematics classes. The classes were observed for one week each during the fall term and the spring term. Mathematics achievement tests were given at the beginning and the end of the study. Observations were made on six target pupils in each class to determine if they were on-task or off-task. They found that about 75% of pupils were generally on-task. However, they found that student absences, late starts to lessons and off-task behaviour accounted for only one-half of the scheduled time being used in academic tasks.

McIntyre, Copenhaver, Byrd and Norris (1983) used an observational study of 10 grade three, 12 grade five and seven grade seven mathematics classrooms to examine student engaged and non-engaged behaviours. They found a slight decline in

engagement rates from grade three to grade seven (77% in grade three compared to 73% in grade seven). In addition, they found that for the grade seven classes, there was more time used for teacher-led activities and less time was used for seatwork than in the grade three classes. Students who were on-task during instruction had higher achievement than those students who are off-task.

A study by Welch et al. (1982) used data from the 1977-78 National Assessment of Educational Progress in Mathematics. It was designed to examine the proportion of variance in mathematics achievement that could be attributed to differences in the number of semesters of mathematics studied. They did a multiple regression analysis comparing mathematics achievement with eight measures of background characteristics plus the number of semesters of mathematics completed. They found that although there were strong relationships between nonschool background variables and mathematics achievement, a stronger relationship was found for the amount of mathematics studied in school. These reporters felt that this finding seems to imply that there is a need for increased mathematics enrolments in the schools.

Attitude and Achievement

Most researchers find a positive relationship between attitude toward a subject and achievement in that subject. All studies that related achievement to attitude reported a

positive relationship. No studies were found that showed a negative effect.

Walberg (1986) did a very extensive synthesis of research studies on teaching. He points out that of 128 studies involving a correlation between self-concept and achievement, 84% of the studies showed a positive effect for a mean correlation or effect of 0.21. This is a low correlation; nevertheless, it is one which shows a positive relationship. Walberg found that the correlations were higher for high school students than for elementary or college students. In eight studies involving ability grouped versus ungrouped secondary classes, 88% of the studies showed a positive relationship with attitude toward the subject matter. Walberg reports on a multivariate analysis of the productivity factors in samples of 13- and 17-year-old students who participated in the mathematics, social studies and science portions of the National Assessment of Educational Progress (NAEP). By statistically controlling many factors affecting achievement and by using many national studies, Walberg showed that achievement in mathematics is positively related to the attitude toward mathematics.

In the IEA studies, a positive relationship between the affective and cognitive objectives of a subject was found. This was true for each country that took part in the study. The variables included interest in the subject and attitudes toward the subject and school. According to Bloom (1981)

evidence from the IEA studies indicate that "students who master the cognitive objectives well, develop positive interests and attitudes in the subject" (p. 44). For example, this implies that interest in science and positive attitudes toward it are positively related to achievement in science. This would also apparently apply to mathematics. Students who are succeeding in school tend to like school and have a positive attitude towards it. The majority of students who were selected to receive the extra time in mathematics had been unsuccessful in mathematics in the past. By offering them extra time, it was hoped that they would experience more success academically and therefore develop a more positive attitude towards mathematics and school.

As part of the BTES (1980) study, Fisher et al. found increasing academic learning time did not result in more negative attitudes toward mathematics, reading or school in general. In fact, they found that "successful students probably enjoy learning more because of their success" (p. 24). They found that any failure, even if it occurred only occasionally, resulted in a more negative attitude among the elementary students studied.

Tsai and Walberg (1983) further analyzed the NAEP data. They found that for 13-year-olds, their attitude to mathematics was influenced by home conditions and by achievement. They found that the more one learns, the better the attitude toward that subject and, conversely, the greater the attitude, the

more one learns. Guskey and Gates (1986) found in their synthesis of mastery learning that students who went through mastery classes developed positive attitudes about their ability to learn as their learning improved.

In a survey of 2500 high school seniors, Sosniak and Ethington (1988) found that the students' attitude toward their academic course work was highly positive whether the student went to a school rated as good or one rated as bad. The rating was based on the academic ability of the students enrolled in the schools, the dropout rate and the reputation of the school within the community. They also found that the students in the poorly rated schools were more likely to rate mathematics courses as very important compared to the students in the good schools.

In order to study the conflicting views of ability grouping, Newfield and McElyea (1983) developed a longitudinal study of high school students and students beyond high school. They found the high achieving sophomores as well as the seniors in advanced mathematics classes were absent less and were more interested in school than even high achieving students in regular mathematics classes. They also found a more positive attitude toward school. Even low achievers in a regular class had more self-satisfaction and did better on an achievement test than did low achievers in remedial classes.

All authors generally found a positive relationship between attitude to a subject and achievement in that subject.

A high success rate in school was found to be a factor that contributes to high levels of self-esteem and a positive attitude to the subject. As Fisher et al. (1980) point out, "students who spent more time than the average in high success activities had higher achievement scores in the spring, better retention of learning over the summer and more positive attitudes toward school" (p. 17).

Recent studies are beginning to focus on the role of motivation as it relates to learning and thinking. According to Resnick and Klopfer (1989), "for many decades, research on motivation has been conducted separately from research on learning or cognition" (p. 7). According to Larkin and Chabay (1989), "the characteristics of effective instruction require that the student be continuously and actively involved in learning" (p. 159). They further claim that extrinsic motivation is less important for success than is intrinsic motivation. A study by Dweck and Elliott (1983, as cited in Resnick & Klopfer, 1989) found that "motivation was intimately related to students' conceptions of intelligence" (p. 8).

Summary

According to Wang (1979), "to provide every child with an 'equal opportunity' to succeed in school, a sufficient amount of time for learning and instruction must be made available to students and teachers" (p. 169).

This review of the literature was undertaken for four

reasons. One was to provide a background of the models which specifically relate time to achievement. A second was to provide a review of studies which focus on achievement as related to allocated time. The third purpose was to provide an overview of the effects of time on learning, especially as it relates to lower ability students. Fourth, the effects on attitudes as learning time increases was explored.

From the review of literature, it would appear that most research studies show a positive relationship between time and learning. However, most researchers claim that there are great differences in the amounts of time allocated to learning activities. The time allocations to different subjects vary markedly among different classes and grades.

Increasing allocated time in schools may or may not improve achievement. This study was designed to help determine if allocating extra time to mathematics will help improve achievement in mathematics for slow learners in a particular instructional program.

CHAPTER III

Methods and Procedures

In this chapter a description of the methods, materials and procedures used in carrying out the study is presented. First, the methods used in collecting the data as well as a description of the groups involved are presented. Then, a description of the materials and instruments used is provided along with the methods used to analyze the data.

Method

This study grew out of a desire to evaluate a program offering help to some lower ability students who received extra time to study academic mathematics. This method was tried by one school under the jurisdiction of the Roman Catholic School Board for St. John's. Since the teachers involved felt that the approach was very successful, the idea quickly spread to other schools in the district. During the 1988-89 school year, there were five high schools offering this program. This researcher is a practicing mathematics teacher with one of the five high schools. Although not personally involved in the teaching of this program, she felt that an evaluation of the program was necessary to determine whether this program was meeting its objective; that is, whether students involved in this program were successful with academic mathematics.

During the fall of the school year 1988-1989, this researcher contacted the seven teachers involved with the teaching of the eight classes receiving the extra time. Each teacher agreed to take part in the study. The initial comments of the teachers towards the program were very positive. Most of the teachers felt that the program was working for the majority of the students involved. The majority of the teachers felt that the attitudes of these students towards mathematics improved as their achievement in mathematics improved. This researcher felt that a study should be undertaken to verify these claims.

To determine if the attitudes towards mathematics did indeed improve, this researcher selected the Sandman Mathematics Inventory (MAI). (See Appendix A). This inventory was one that had been used by the school board on previous occasions. This same instrument was given to the students who received the extra time. It was given to the students prior to the Christmas break 1988 as a pretest. The same inventory was given in late May 1989 as a posttest. T-tests were used to analyze the data to determine if there had been a change in attitude on any of the six constructs measured by the inventory. (See Table 2). The numbers do not agree for the pretest and posttest because the tests were given to the students present in class on the day of the testing. No names were requested on the attitude surveys.

Table 2

Students Completing the Sandman MAI

	<u>Level I</u>	<u>Level II</u>
	Mathematics 1203	Mathematics 2203
Pretest	97	26
Posttest	65	31

To determine the achievement of these students, the researcher contacted each teacher involved with the program to obtain the final June result for each student. Prior to this, this researcher had each student complete a questionnaire requesting information on the student's grade nine mark and homework habits. (See Appendix B). In addition, the researcher constructed two 25-item tests (Appendix C) to be given to the students in Academic Mathematics 1203 and Academic Mathematics 2203 who had received the extra time. This researcher analyzed this data by obtaining the mean scores for each test. These means were then compared with the grade nine mark to determine if there had been any improvement.

An effort was made to determine if the achievement of these students could be compared to similar students who had not received the extra time. To do this, this researcher contacted teachers in seven high schools under the jurisdic-

tion of the school board. The tests constructed by this researcher were administered to 313 students who had received six periods to study academic mathematics. This researcher then contacted the school board office as well as the different high schools to obtain the Canadian Achievement Test in Mathematics (CATM) score for as many of these students as possible. This score was one in a battery of tests given to all grade nine students in the district. This score was also obtained for the 128 students who had received the extra time. Of the 128 students, the highest percentile rank on the mathematics component was 51. Therefore, this score was selected as the highest score used for comparison with the group who did not receive the extra time. Of the 313 students tested, 177 were found to be below the 51st percentile on the CATM test. These 177 students were selected for comparison with the 128 students who had received the extra time. The June mark was also obtained for the students who had not received the extra time. This mark as well as the one obtained on the researcher-made test were compared by using ANCOVA. The CATM mark was to be the variable controlled. The June exam mark and the researcher-made test mark were the dependent variables.

Most of the literature review revealed that time on task was a most important condition if time increases were expected to result in increased achievement. To assess just how the extra time was being used, this researcher contacted two of

Table 3

Enrollment and Time Allocations to the Mathematics Courses

	<u>Level I</u>		<u>Level II</u>	
	Mathematics 1203		Mathematics 2203	
	Allocated	Allocated	Allocated	Allocated
	9 Periods	6 Periods	9 Period	6 Periods

Total	85	210	43	103
< 51st percentile	85	122	43	55

the seven teachers involved with the program. Both teachers agreed to have a video camera set up in their classroom. This was designed to reveal if the students were indeed on task. Both classes (one group was studying Academic Mathematics 1203 and one was studying Academic Mathematics 2203) were video-taped five times each. This researcher personally set up the camera at the front of the room each time and then left the room. The camera was focused on the students and not on the teacher. This might help determine if the students were consistently on task doing mathematics. The idea of the video camera was used because this researcher was not able to observe the classes directly.

In addition, to obtain some more information on how the

extra time was used, this researcher interviewed each of the seven teachers involved. As well, the mathematics coordinator with the school board made available to the researcher the reports that five of the teachers involved with the program had submitted to the board. These reports outlined the various teachers' opinions on the program. They also helped provide some background information on the program.

Materials and Instruments

The scores from the Canadian Achievement Test in Mathematics (CATM) were obtained to assess each student's ability in mathematics. The results of this test were available from the Roman Catholic School Board, since each student in grade nine is required to take the CAT battery of tests. The mathematics component is one of four tests developed in Ontario as a result of a longitudinal study of approximately 90,000 grade nine students in 1959.

The test consists of 30 items (15 in Algebra, 12 in Geometry, and 3 in mensuration). According to Morrison (1965), the test "reflects ... a limited point of view concerning the high school mathematics curriculum" (p. 566). He further claims that it has "inadequate technical qualities in test construction" (p. 566). He claims that the CATM test may have limited content validity but felt that the test may have some value for "those in Ontario and elsewhere who wish to compare their pupils with that province with respect to their achieve-

ment" (p. 566).

Despite the poor rating given by Morrison (1965), the score on this CATM test was selected for this study because it was the most recent standardized test result available for these students. Then too, the CATM score was one of the factors by which these students were assigned extra time for mathematics.

The CATM test was administered to all grade nine students of the Roman Catholic School Board. The scores were available from the various schools participating in the study or from the school board. Students for whom the researcher could not find a score either had been absent on the day of testing or were transfers into the school board after the test was administered.

To determine achievement on the high school academic mathematics, the researcher developed two 25-item completion tests (Appendix B); one for Mathematics 1203 and one for Mathematics 2203. These were administered to the classes participating in the study near the end of May 1989. They were administered to all groups during a regular class period. The test was constructed according to the requirements of the curriculum guides for Academic Mathematics 1203 and 2203 of the Department of Education, Government of Newfoundland and Labrador. The teachers involved with the teaching of these courses were asked to comment on the items. Without exception, each teacher felt that the items were consistent with the

course description and were similar to ones that they themselves would use on chapter tests.

The reliability of the completion tests was determined using Cronbach's coefficient alpha. The results of the reliability calculations are presented in Table 4.

Table 4

Reliability Coefficients for Researcher-Made Tests

Level I (25 items)	Alpha = 0.7602
Level II (25 items)	Alpha = 0.7767

Each individual item in both of the tests had an alpha coefficient in the range of 0.7 to 0.8. Therefore, the researcher felt that both tests were reliable instruments to evaluate the content of Mathematics 1203 and 2203.

According to Dyer (1979), "no minimum level of reliability can be established to fit all occasions" (p. 120). Even though it is true that the higher the reliability coefficient, the better Dyer contends that "tests with reliabilities as low as .50 may still be acceptable" (p. 120) for many research studies.

The items on both tests were scored as right or wrong according to the answer keys. (See Appendix D). The researcher-made test was correlated using the Pearson's r with

the CATM score and the June mark. The results are given in Table 5. As well, the June mark and the researcher-made test had a correlation of 0.6054 with $p < .01$.

Table 5

Pearson Correlation of Researcher-Made Test with CATM Score and June Mark

	June Mark	Researcher-Made Test
CATM	.3806	.3779
	$p < .01$	$p < .01$

To assess the attitudes of the students who had received the extra time in mathematics, the Sandman Mathematics Attitude Inventory (MAI) was used. The test consists of 48 statements with four answer choices: "strongly agree," "agree," "disagree," and "strongly disagree." The test was designed to measure a student's attitude towards mathematics on six constructs; perception of the mathematics teacher, anxiety towards mathematics, value of mathematics in society, self-concept in mathematics, enjoyment of mathematics, and motivation in mathematics. Each construct is represented in a certain eight items randomly placed throughout the test.

The scale was validated using a sample of 2547 students

(1338 grade eight and 1209 grade 11) in two states, California and Indiana. The Cronbach's Alpha was used to determine the reliability of each construct. (See Table 6). The high correlations indicated that the items for each scale are measuring the same thing and that all of the items fit well into the respective scales.

Table 6

Reliabilities of the Six Defined Scales of the Mathematics Attitude Inventory as Determined by Cronbach's Alpha Coefficient--All Students Combined

Scale	Reliability
1. Perception of the mathematics teacher	.83
2. Anxiety toward mathematics	.86
3. Value of mathematics in society	.77
4. Self-concept in mathematics	.83
5. Enjoyment of mathematics	.85
6. Motivation in mathematics	.76

Source: Sandman (1973), Table 11, p. 54

Sandman (1973) also completed a factor analysis of the inventory which showed that the six attitude constructs

measured six empirically distinct constructs. This was taken as strong evidence for the internal validity of the instrument. The enjoyment factor was found to be the strongest factor of the inventory with the motivation factor as the weakest.

Sandman (1973) calculated the external validity for his instrument by comparing the results of his study with previous studies. He found evidence for varying degrees of support for the external validity of the anxiety, value of mathematics, self-concept and the enjoyment factors. However, estimates of the external validity of the perception of the teacher and the motivation factors were not available.

To determine whether students were successful in the academic mathematics courses, this researcher obtained the June (end of course) mark for all students in the eight classes. Although this mark was not based on a single examination common for all students, each school gave a comprehensive examination on the entire year's work. Students in each school completed the same examination for that school whether they had six periods of mathematics instruction or nine.

To obtain some information about how the extra time was used, the researcher conducted interviews with the seven teachers involved in teaching these students. As well, information was obtained on student attendance patterns and homework completions. Four of the teachers had completed comprehensive reports for the school board on the program and

copies of these reports were obtained by the researcher. These reports gave further information on the use of time and on the teacher's opinion of this particular approach.

CHAPTER IV

Presentation and Analysis of Data

Introduction

The purpose of this study was to evaluate a program which provided for extra time to some lower ability students as they attempted to study academic mathematics. To accomplish this task, this researcher collected data in several ways. This chapter will report on the results of these efforts. First, a presentation of the data collected on this particular group of students will be presented. Secondly, the results obtained when this group of students were compared to a similar group of students who did not receive the extra time to study academic mathematics will be presented. Finally, the results of the videotaping done to determine how the time was used will be reported.

Descriptive Data on Group Under Study

As much data as possible was collected concerning this group of students. This task was accomplished by talking to the teachers concerned, by reading the written reports submitted to the school board, and by using the questionnaire completed by these students. As well, several evaluation marks were collected for each student in the program. These included the end of year examination mark, the mark on the 25-item researcher-made test, and the standardized CATM score. In

addition, the Sandman Mathematics Attitude Inventory was given as a pretest and as a posttest. First, this section will present the findings based on the students and then it will present the reactions of the teachers themselves. Finally, the analysis of the achievement will be presented.

Students.

The data from 128 students were considered for the analysis of the results. A total of 144 students began the study of academic mathematics with the extra time assigned in September 1988, but 16 of these students dropped out of school during the course of the school year.

The students who were assigned to these classes were selected on the basis of their scores on the CATM test and on their grade nine or 10 marks. Many of these students had a history of failure in mathematics and had expressed dislike for mathematics. To determine initially the characteristics of this group, a questionnaire (Appendix B) was developed and administered to this group of students. Though, the students were asked for their grade nine mark in mathematics, 45 (35%) of the students could not remember or failed to report their mark. Of the remaining 83 students, 13 (10%) reported a failing mark and 17 (13%) remembered receiving a mark of 50 on grade nine mathematics. Twenty-nine (23%) students reported that they had received a mark between 51 and 60. The remaining 24 (19%) students gave a mark between 61 and 80.

The CATM scores for the students involved in the study were collected by visiting the five high schools involved with the program. Of the 128 students, 20 marks on the CATM could not be found. This was due to the fact that some of these students had been absent from school when the test was administered in grade nine. A number of these students were new to the school board and therefore had not taken the test. The range of the CATM score (percentile score) for this group is given in Table 7. The mean of the CATM scores for this group was at the 35.9 percentile.

Table 7

Range of Scores From Canadian Achievement Test in Mathematics (CATM)

Range of Scores (Percentiles)	Number of Students	Percentage
3 - 10	8	7.4
11 - 20	34	31.5
21 - 30	39	36.1
31 - 40	17	15.7
41 - 50	9	8.4
51	1	0.9
unknown	20	-
Total	128	100.0

Of the 128 students, 61 were male and 67 were female. Eighty-five of these students were studying Academic Mathematics 1203 and 43 were studying Academic Mathematics 2203.

The questionnaire was used to reveal a number of characteristics of the group as a whole. When asked about the time spent on homework as well as the time spent on mathematics homework, the following responses were obtained (Table 8).

Table 8

Time Spent on Homework and Mathematics Homework

	Number	Percent
Total Homework		
Less than 1 hour	32	35.2
1 to 2 hours	52	57.1
More than 2 hours	7	7.1
Missing	37	-
Total	128	100.0
Mathematics Homework		
Less than 15 minutes	22	24.2
15 to 30 minutes	57	62.6
More than 30 minutes	12	13.2
Missing	37	-
Total	128	100.0

Only four (3.1%) of the students surveyed declared that their parents or guardians checked their homework every night. Forty-one (32.0%) said that their parents sometimes checked their homework. Forty-four (34.4%) reported that their parents never checked their homework. Thirty-nine students (30.5%) omitted this question. The students were also asked about their attendance in mathematics classes. The following responses were obtained (Table 9).

Table 9

Mathematics Classes Missed During the School Year

	Number	Percent
Fewer than 5	25	28.4
5 to 10	39	44.3
10 to 20	15	17.0
Over 20	9	10.2
Missing	40	-
Total	128	100.0

Forty-seven students (52.8%) declared that there was someone at their home who could help them with mathematics if there was a problem. Forty-two students (47.2%) said that

there was no one at home who could help them with mathematics. Thirty-nine students failed to answer this question. When asked who they would go to for help if they were experiencing difficulty with mathematics, the following responses were obtained (Table 10).

Table 10

Source of Help With Mathematics If Student Is Experiencing Difficulty

	Number	Percent
Parents or guardians	7	9.1
Teachers	42	54.5
Friends	19	24.7
Relative or other	9	11.7
Missing	51	-
Total	128	100.0

Despite their apparent inadequate background in mathematics, these students wanted to complete academic mathematics in high school. Presumably, because of their past experience, they all opted for the choice of extra time. When questioned about their opinion of nine periods of mathematics, many of

the students were positive about it. Most students expressed a desire to continue with this method during the next school year. Some of the comments of these students are given below.

Student 1: I think that nine periods of math a week is a lot but I think it pays off, because I am doing way better this year than I did in grade eight and nine because for those two years I had to go to Summer School.

Student 2: Math for me up until Level I has been no help to me because I couldn't get a grasp on what was being taught and when I got to Level One with the three extra periods I became good at Math. I also enjoyed going to math class because at least I had a clue of what was going on and my mind wasn't in a spin.

Student 3: In the early years before grade 10 I found math difficult. I passed by the skin of my teeth, but in grade nine I bombed greatly. But then I came to grade 10 and you said you would offer a double period of Math. At first I was on two minds of taking it but I decided to try it. The results of this were quite successful I think, taking this course gave me a good grip on math.

Student 4: Before I didn't enjoy math because we were put in a class with people who caught on fast and people who never did. Therefore, we were going

at a different pace and the people who found math difficult were usually left behind. This year ... we're not rushing into anything, we're taking our time and going through it easily ... I'm not getting great marks in math still, but at least I understand it better and I'm not doing as bad as I did last year.

Teachers.

There were seven teachers involved in the teaching of these students during the school year 1988-1989. One of these teachers taught two groups: one Level I group and one Level II group. Of the eight classes involved in the study, three classes were Level II (Academic Mathematics 2203) and five classes were Level I (Academic Mathematics 1203).

Each teacher was interviewed by this researcher personally in an effort to determine how the extra time was being utilized, to gather their ideas and feelings on the effort to help these students, and to obtain information of the type of student involved in the program, this from the teacher perspective. Five of these teachers had completed a report on this program for the Roman Catholic School Board. Copies of these reports were obtained by this researcher to assist in the assessment of the program.

All seven of the teachers interviewed stated that most of the extra time allocated was used for more concentrated drill

and practice of the topics covered in class. Two of the teachers had used a diagnostic test in September to determine the strengths and weaknesses of these students. From these test results, a block of time was used to develop some basic algebra skills before the prescribed course outline was begun. One of the remaining teachers used the early part of the course to develop pre-algebra skills with the class. Three of the teachers interviewed also reported using the computer as a means of reinforcing concepts and skills taught in class. According to one of these teachers, the students enjoyed their computer time greatly, apparently because it was a change from the normal pencil and paper work sheet as drill and practice. Most of the software used with this group, however, was drill and practice in its nature. Skills such as factoring and coordinate geometry formulas were supplemented in this manner. Another teacher from a different school used computers to help with the teaching of graphing. He felt that the students enjoyed this experience and learned from it. This teacher would have liked to use more computer applications but expressed a frustration with a lack of software at the school.

Even though some time was spent on these various methods, all seven teachers reported that most of the extra time was used for a review of basic skills, extra drill and practice, and more personal attention. According to one teacher:

The fundamental difference is the slower pace of the nine-period course, permitting increased stu-

dent/teacher contact, enabling the teacher to better identify and resolve learning difficulties. Simultaneously, the additional three periods allow more time and practice for the slower students to grasp the concepts.

Another teacher claimed that "the retention rate of many of these students is very weak, as much repetition of work as possible is required."

For the most part, the teachers claimed that the students in these groups have a poor work ethic. Many of them seem to hate school in general and mathematics in particular. Many of these students entered high school feeling that they were no good at mathematics and would not be able to do it. According to one teacher, "their negative feelings toward mathematics were easily detected and some were convinced they could not understand anything of a mathematical nature." As a consequence, this teacher claimed that initially the most frustrating aspect revolved around "their inappropriate behavior" which led to difficulty with keeping "a balance between insisting on productive work habits without creating excessive tension and providing these students with successful learning experiences."

According to the teachers, most of these students come from average to below average socio-economic backgrounds. In many cases, parental support and encouragement is lacking. Several teachers commented that the attitude of many of these

students was poor. It was reported that many of them were "lazy" and did very little homework.

Nevertheless, all seven teachers interviewed felt that there was an improvement in the attitudes of these students as the year went on. All teachers, without exception, felt that the slow students who worked at their mathematics definitely improved because of this extra time. Three of the teachers felt strongly that "many of these students would not have passed six-period math." Six of the seven teachers expressed a belief that they were pleased with this approach to helping slower students. As one teacher put it: "I feel that the continuation of this course will indeed be a benefit to the students."

Several of the teachers reported that the absentee rate of this class was approximately the same as their other academic mathematics classes. However, one teacher complained that the absenteeism in this group was a "real headache."

Many of the teachers interviewed stressed the fact that offering extra time to slow students who have no interest in school work does not work. As one teacher put it: "this program is not designed, nor should it be, to cater to those (students) whose main reason for failure is a lousy attitude." Again, all seven teachers strongly felt that this program works best when the students really want to do academic mathematics and are willing to do their part to experience success with it.

Because of the size of several of the high schools offering this approach, two of the seven teachers involved in the program did not have a complete class group for the nine periods. Five of the eight classes were taught as a group by the same teacher for nine periods. In three of the classes, the students who received the extra time were in a larger group for six periods. Then they received the extra three periods as the rest of the class were taking a different course. All teachers involved with these groups felt that having a complete group for nine periods would be the most desirable way to teach these students. Teaching a smaller group for three extra periods was more like a tutorial class. This approach led to a smaller group which allowed for more individual attention but it lacked the continuity of the groups who were together for the nine periods.

Analysis of Data on Extra Time Group

The scores from the June examinations in mathematics and the scores on the researcher made tests (Appendix C) were analyzed. The Statistical Package for the Social Sciences (SPSS-X) was used for the analysis.

Analysis of achievement.

Table 11 presents a summary of the results of the June examination results for this group of students.

Table 11

Achievement of Whole Group on June Examination in Mathematics

	Number	Percent
Failing Mark < 50	45	35.7
50	13	10.3
61 - 60	34	27.0
61 - 70	26	20.7
71 - 80	7	5.5
83	1	0.8
Missing	2	-
Total	128	100.0

The mean score of the group was 50.4. From this data, it can be seen that 65% of the students who received extra time to study academic mathematics were successful. The highest mark obtained was 83 and 26.6% of these students received a mark above 61.

Tables 12 and 13 present the data based on the June examination results for Academic Mathematics 1203 and 2203 separately.

Table 12**Achievement of Students Taking Academic Mathematics 1203**

	Number	Percent
Failing Mark < 50	31	36.5
50	7	8.2
61 - 60	26	30.6
61 - 70	15	17.6
71 - 80	4	4.7
83	1	1.2
Unavailable	1	1.2
Total	128	100.0

Table 13**Achievement of Students Taking Academic Mathematics 2203**

	Number	Percent
Failing Mark < 50	14	32.6
50	6	14.0
61 - 60	8	18.6
61 - 70	11	25.6
71 - 80	3	7.0
Unavailable	1	2.3
Total	43	100.0

The mean mark for the June examination results for Academic Mathematics 1203 was 49.8 and the mean mark for Academic Mathematics 2203 was 49.4. Sixty-three point five percent of the students studying Academic Mathematics 1203 were successful whereas 67.5 % of the Academic Mathematics 2203 students were successful.

The mean of these scores was 5.9. Both tests (Mathematics 1203 and 2203) reflected similar results. The mean score for Mathematics 1203 was 6.3 and the mean score for Mathematics 2203 was 5.1.

The scores of the researcher-made test were very poor. These tests consisted of 25 items based on the course outline, which were administered near the end of May. At this time, the course was finishing and most of the students had not begun their review of the year's work in preparations for the June examination. The poor results may also reflect an apparent low retention rate on the part of these students (Table 14).

Table 14

Achievement of Group Based on 25-Item Researcher-Made Test

	Number	Percent
0 - 5	47	48.0
6 - 10	31	31.6
11 - 15	19	19.4
16	1	1.0
Missing	30	-
Total	128	100.0

Analysis of attitude data.

In Table 15, a summary of the results of the t-test used to analyze the attitude data is presented.

All the p values exceed the accepted alpha value of .05. Therefore, in statistical terms, there was no significant difference in the means of the pretest and the posttest. This was true for all six constructs of the attitude survey.

In addition, in considering the rule (Chapter III) given for practical significance by Borg (1987), none of the constructs show any practical significance. It can be concluded that the attitude of this group of students did not change significantly.

Table 15

Comparison of the Pre and Posttest Results of Attitudes Towards Mathematics

Constructs	Pretest	Posttest	t	p
	Mean and S.D. N = 123	Mean and S.D. N = 95		
Perception of Math-	3.31*	3.35	-.63	.265
ematics Teacher	.54	.46		
Value of Mathematics	2.92	3.00	-1.00	.160
in Society	.53	.59		
Anxiety Towards	2.32	2.38	-.69	.245
Mathematics	.53	.61		
Self-Concept in	2.47	2.41	.72	.235
Mathematics	.53	.60		
Enjoyment of	2.22	2.31	-1.27	.103
Mathematics	.52	.62		
Motivation in	2.35	2.31	.60	.276
Mathematics	.47	.56		

*maximum = 4.00

On further inspection of the means, some increases and decreases can, however, be noted. The mean of four of the constructs increased slightly. These included the perception

of the mathematics teacher, the value of mathematics in society, anxiety towards mathematics, and the enjoyment of mathematics. Of these, the surprising result was the slight increase in the mean for anxiety towards mathematics. The researcher had expected a decrease in this construct.

Two constructs, (a) self-concept in mathematics, and (b) motivation in mathematics showed a slight decrease on the means of the posttest over the pretest. This may not be surprising since the posttest was completed in late May and at this time of the school year, the students are finishing their courses of study and preparing for June examinations. Depending on their marks during the year, their self concept may be affected. Also at this time of the year, students are likely to be tired and their interest in school work often wanes.

Comparison of Groups

To determine the achievement of these students compared with similar students who had not received the extra time, this researcher obtained the CATM score and the June scores from students who had not received the extra time. Also, the researcher made test was given to these students in late May. Only those students who scored below the 51st percentile were selected for comparison.

Three hundred and thirteen students in the various high schools of the Roman Catholic Board for St. John's completed the questionnaire and the 25-item test. This researcher also

obtained the June examination mark and the CATM score for as many of these students as possible. From this group, 177 students were chosen for comparison with the 128 students who had received the extra time. These were selected because they had scores less than or equal to the 51st percentile on the CATM test. One hundred and twenty-two of these students had completed Academic Mathematics 1203 and 55 had completed Academic Mathematics 2203. The range of CATM scores is presented in Table 16.

Table 16

Range of Scores From Canadian Achievement Test in Mathematics
(Students Receiving Six Periods of Mathematics)

Range of Scores (percentiles)	Number of Students	Percentage
1 to 10	7	4.0
11 to 20	24	13.6
21 to 30	41	23.2
31 to 40	49	27.7
41 to 50	44	24.9
51	12	6.8
Total	177	100.2

Comparing this range of scores with the previous table for the group receiving extra time, it can be noted that the majority of this group have CATM scores between 31 and 51 (59.4%) whereas only 25.0% of the group receiving extra time were in the range of 31 to 51.

The results of the questionnaire revealed that the two groups were similar in most respects. When asked about the time that they spent on homework in total and mathematics in particular, the results shown in Table 17 were obtained. Comparison of this result with the group receiving the extra time reveals very similar results as shown earlier in Table 8.

When asked to whom they would go for help if they were experiencing difficulty with mathematics, the following results were obtained as shown in Table 18.

It is interesting to note that more students in this group (42.5%) said that they would seek help from their friends compared to only 24.7% in the first group. The students in the group receiving the extra time seemed to rely on help from their teachers (54.5%) more than did students who had not received the extra time (43.1%).

Table 17

Time Spent on Homework and Mathematics Homework

	Number	Percent
<hr/>		
Total Homework		
Less than 1 hour	68	38.6
1 to 2 hours	91	51.7
More than 2 hours	17	9.7
Missing	1	-
Total	177	100.0
Mathematics Homework		
Less than 15 minutes	54	30.7
15 to 30 minutes	104	59.1
More than 30 minutes	18	10.2
Missing	1	-
Total	177	100.0

Table 18

Source of Help With Mathematics If Student Is Experiencing Difficulty

	Number	Percent
Parents or guardians	3	3.1
Teachers	69	43.1
Friends	68	42.5
Relative or other	17	10.6
Missing	17	-
Total	177	100.0

Achievement.

The results of the June examinations and the 25-item tests are presented in Table 19 for the group receiving the six periods of mathematics instruction.

The mean score for this group was 53.9. This was slightly higher than the score of the group receiving the extra time, which was 50.4. However, the overall results were similar to the other group with 71.8% of this group successfully passing academic mathematics. This compares well with the 64.3% of the first group who were successful.

Table 19

Achievement of Group on June Examination in Academic Mathematics

	Number	Percent
Failing Mark < 50	50	28.2
50	15	8.5
61 - 60	54	30.5
61 - 70	34	19.2
71 - 80	18	10.2
Over 80	6	3.4
Total	177	100.0

The achievement of this group on the 25-item researcher-made test is presented in Table 20. The mean score was 6.2. This too is quite similar to the mean of 5.9 that the students receiving extra time obtained.

The achievement data was compared using a two way ANOVA (Analysis of Variance). The results of the analysis for the June examination marks and for the 25-item test are reported in Table 21.

Table 20

Achievement of Group Based on 25-Item Researcher-Made Test

Score (Out of 25)	Number	Percent
0 - 5	71	40.1
6 - 10	76	43.0
11 - 15	26	14.1
16, 17	4	2.8
Total	177	100.0

There was no significant difference for the students who received the extra time compared to those who did not on the 25-item researcher-made test. However, on the June exam ($p < .10$) shows that the number of periods did have an effect on the June final result. It should be noted that caution must be exercised when interpreting this result. The students were not randomly assigned to the treatment. Many factors may have contributed to this result. Therefore, it can not be stated with certainty that time was responsible for this effect.

Table 21**Analysis of Variance Summary Table for June Examination Marks**

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
Main Effects					
Periods (6 or 9)	705.328	1	705.328	3.212	.074*
Math (1202 or 2203)	943.867	1	943.867	4.299	.039**
Interaction					
Periods x Math	111.766	1	111.766	.509	.476
Residual (Within)	56248.147	257	219.565		

*p<.10

**p<.05

Table 22**Analysis of Variance Summary Table for 25-Item Test**

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F
Main Effects					
Periods	23.396	1	23.396	1.597	.207
Math	79.103	1	79.103	5.401	.021**
Interaction					
Periods x Math	1.659	1	1.659	.113	.737
Residual (Within)	3764.185	257	14.647		

*p<.10

**p<.05

The effect due to mathematics course taken was significant at the .05 level. This would imply that the level of the course that the students were taking (Academic Mathematics 1203 or Academic Mathematics 2203) did have an effect on the June result and on the 25-item test score. Again caution should also be exercised here. Other factors--such as age of students--may have contributed to this difference.

There was no significant difference when the number of periods and the level of mathematics was tested for the dependent variables (June mark and 25-item test). This would imply that no effect could be attributed to an interaction between the independent variables (number of periods and mathematics course taken).

Videotape

This researcher personally set up the small video camera in the front of each classroom agreeing to take part in the study. Two of the eight classes were videotaped. Both of these classes were taped five times. One of the classes was Academic Mathematics 1203 and one was Academic Mathematics 2203. The camera was small and thus it could not be focused on every desk in the classroom. The camera was focused on the students and not on the teachers.

This researcher viewed the videotape. As a practicing mathematics teacher, this researcher felt that what went on in the classes taped was typical of a normal academic mathematics

class. Both teachers spent approximately one-half the allotted time at the blackboard correcting homework and introducing a new concept. The students generally listened to this presentation and took notes of the examples done. Most students appeared to be on-task. However, one or two did not appear to be as attentive as they might have been. Of course, having a camera in the classroom could have affected the normal routine of the class. A number of students may have acted differently if the camera were not present. After the first day or so, though, the students would have tended to forget about the camera and apparently would act as normal.

After assigning seatwork, the teachers would go around the classroom and offer help to students requesting it or appearing to have trouble. Again, most students seemed to make an effort to do the assigned work. Very few students asked to leave the room during these taped classes. The camera in the classroom may have had an effect on this. Some students appear to be more motivated to work than others. The classes appeared to be similar to a normal class setting for mathematics as far as this researcher could ascertain.

CHAPTER V

Summary, Conclusion, Discussion and Recommendations

Summary

This study was carried out in an effort to evaluate a program of helping some students with demonstrated lower ability in mathematics to achieve in academic mathematics. According to Cronbach (1963, as cited in Schubert, 1986), evaluation should be "designed not merely to judge outcomes of what students learned, but ... serve as a basis for assessing the entire process" (p. 265). Miller and Seller (1985) also claim that evaluations "provide information for decision making" (p. 301). Evaluations of courses or programs are presumably undertaken for the improvement of the course. Decisions from these evaluations might involve continuing, modifying, or terminating a program.

The program I attempted to evaluate was based on the premise that offering extra time to certain students would help them become more proficient in academic mathematics. According to the available literature reviewed here, the majority of writers report that increasing time does increase achievement. A limited number of research studies were found which examined time and achievement for secondary students. Then too, much attention has been given lately to increasing time in school by lengthening the school day or year.

This particular program obtained extra time for these students by allowing them to take thirteen credits in a school year instead of the normal 14 credits. If successful, an individual student would still have the 36 credits necessary for graduation.

To evaluate this program, I interviewed the teachers involved in the teaching of these students. I obtained the CATM score, the June mark in grade nine and the June mark for the academic mathematics course taken. As well, each student completed a short questionnaire and a 25-item researcher-made test based on the course outline. Finally, the students in the program completed an attitude inventory twice--once early in the year as a pretest and again later in the year as a posttest. As an attempt to set up a comparison, I also obtained the CATM score, June score, questionnaire and researcher developed test score for a comparable group of students. Finally, I videotaped two of the groups receiving extra time to obtain some information on how the extra time was being used.

A number of descriptive findings were obtained and were presented in Chapter IV. Comparing the two groups quantitatively revealed very little or no significant difference that could be attributed to the factor of time.

Conclusion

I began this study in an attempt to investigate and

evaluate the practice of increasing allocated time as a means of helping some lower ability students with academic mathematics. After reflecting on the data and methods used, I cannot say in good faith whether or not the program was beneficial or not. If I were expected to offer a recommendation to the board concerning continuing or dropping the program, I would not feel justified in doing so.

Seven of the eight teachers involved with the teaching were very positive about it. The school board is committed to this program. In fact, the program has been introduced in at least two other high schools in the board since I began this study. It has also been introduced to some students who wish to study advanced mathematics. However, most teachers felt that a careful screening of the students who are to be admitted to the program should be done. Increasing the time for those students who do no homework, are frequently absent from school and have an overall poor attitude to school will not in their minds be successful. Most teachers felt that enrollment should be restricted to those students who are having great difficulty with mathematics but who are willing to work hard, do their homework, and come to school regularly. For this type of student, all teachers felt that the program would be beneficial. Indeed, some teachers felt that such students will not be successful with academic mathematics without the extra time.

The comments from the students were also very positive.

However, one could ask: Were they genuine or were they answering this way to please their teacher? The students involved in the program willingly agreed to study mathematics by having the extra time. This meant that they would knowingly be losing a credit. This brings into consideration the possibility of the Hawthorne Effect playing a role. The performance of these students may have improved simply because they were willingly participating in this program and thereby receiving extra attention. Borg and Gall (1983) claim that "the influence of the Hawthorne Effect can be expected to decrease as the novelty of the new method wears off" (p. 215). This program had been in existence for four years before this study was begun. It had existed in some schools earlier than others. The excellent results experienced during the early years may well have been influenced by the Hawthorne Effect. As well, many of the students participating in this program could have been affected by this special treatment. As a consequence, the results of the study may have been affected by this effect.

The data on achievement revealed that there seemed to be no significant difference between the two groups. This could imply that increasing allocated time does not appear to improve achievement. However, I am not so sure that this conclusion can be drawn. Many other factors could well come into play. If there were students in the group who had bad attitudes, poor work habits, and poor attendance, then their

marks might well have affected the overall mean. This in turn would affect the results.

The results of this study indicate that allocating extra time of itself to these students is an unrealistic way to improve their achievement. Undoubtedly, some of the students benefited from this program. However, others might have been successful in the regular program, had they been given some extra attention within the regular program. Other factors may have played a role in the success of the program if it can be deemed a success. The competence of the teachers involved could be one factor. True, most of the teachers interviewed seemed to me to be very caring and competent. This must have had an effect on program results. As well, most of the students were in small classes or groups; and again this could have had an effect. Although it would seem plausible to suppose that allocating extra time would help these students, at the end of this study I cannot now say with any confidence whether it did or did not.

In conclusion, then, I began this study in 1987. I had intended and hoped to determine the effectiveness of a program that offered extra time to some students within the board who had a prior poor background in mathematics. After having spent a good deal of time evaluating this program, I have learned that:

1. The school board and the teachers involved with the program are very much committed to this program and have great

faith in it.

2. There was no significant difference in the means of the attitudes towards mathematics of the students who received the extra time as compared at the beginning of the program to the later part of the year.

3. There was no significant difference in the achievement of those students receiving the extra time as compared to the comparable group who did not receive the extra time.

4. Based on my experience with mathematics teaching, the videotaping did not reveal any differences in methodology. It appeared that these teachers used the same methods of teaching mathematics that are normally used; that is, presentation of the material on the blackboard followed by time for seatwork which was used by the teachers to assist the students needing help.

In my judgment, because of the impact of several limiting factors, this study failed to reveal any significant differences. These factors are for the most part a result of a lack of control on the conditions within the study. These include:

1. The teachers involved with the program were responsible for the assigning of the final grades received by the students in both groups.

2. Each of the teachers involved with the program used his own method throughout the year under study.

3. The researcher also had no control over the students that were selected and their assignment to classes.

4. The researcher had no control over the size of the groups. It happened that the groups receiving extra time were for the most part smaller than the groups that did not receive the extra time.

Even so and in light of the limitations on this study, the researcher was in fact attempting to work within a real school situation. Given this situation, it was not possible to exert control. Again, it should be stressed that this study is to be considered as action research and, as such, the researcher was dealing with the real and not with an ideal situation. What is more, as Novak and Gowin (1984) put it, educational experiences are complex events; "the learner must choose to learn" (p. 6). The several teachers involved with the program determined the agenda and the sequence of concepts to be presented. The Government of Newfoundland and Labrador set the curriculum to be covered. Novak and Gowin further state that "the milieu is the context in which the learning experience takes place and it influences how teacher and student come to share the meaning of the curriculum" (p. 6). This milieu would likely have varied greatly among the eight classrooms involved in this study. Without a greater and wider degree of control over the situation, it would be difficult to speak realistically about significant differences.

Having been through this experience, I feel that I am now much better prepared to evaluate this program. However, I feel that I could not have reached this understanding if I had not

worked through this situation personally. If I were to do this evaluation over again and had an "ideal" set of conditions to work with, I would:

1. Select the students beforehand by using a standardized mathematics achievement test in conjunction with demographic data.
2. Assign by appropriate means a group of these students to receive nine periods of mathematics instruction a cycle and a similar group who would receive six periods of instruction a cycle.
3. Exercise a degree of control over class size of both groups.
4. Have the same teacher teach both groups.
5. Administer a final evaluation based on the course outline that was developed by myself.
6. Score the evaluation personally.

Discussion

I began this study by trying to determine if a program of offering extra time to certain lower ability high school students was successful in helping them achieve in academic mathematics. I attempted to answer the question: Will low ability high school students who receive extra time for mathematics instruction during a six-day cycle achieve more success studying academic mathematics than will similar low ability students who do not receive the extra time?

The data I collected did not answer adequately the above stated question. I discovered that evaluating mathematical understanding is very difficult, this by reason of the very nature of mathematical principles and structures. According to Resnick and Ford (1981), in order to evaluate mathematical structures "one would have to be able to define psychologically the mathematical structures one wished to teach and also be able to assess the degree of understanding a learner had before and after instruction" (p. 126). These scholars also claim that very little is known about the effects of curriculum reforms on the quality of mathematical learning. Furthermore, in a recent publication entitled Education and Learning to Think, Resnick (1987) claims that "the task for those who raise the intellectual performance levels in children is not just to teach children new cognitive processes but to get them to use those processes widely and frequently" (p. 42).

Recently, much emphasis has been placed on learning to think mathematically. Organizations such as the National Council of Teachers of Mathematics (NCTM), with their much talked-about Curriculum and Evaluation Standards for School Mathematics, and the National Research Council (NRC) are placing great emphasis on developing thinking skills in our students. The Association for Supervision and Curriculum Development (ASCD) people have entitled their 1989 yearbook Toward the Thinking Curriculum and have devoted two chapters to teaching skills related to mathematics. According to

Resnick and Klopfer (1989), in this yearbook, teaching a thinking curriculum means to "teach content and skills of thinking at the same time" (p. 5). Mathematical concepts have to be taught because learning mathematics requires prerequisites for learning any future basic knowledge. This knowledge can then be applied in the broader contexts of reasoning and problem solving.

Furthermore, a great deal of research and discussion is presently being centered on the actual teaching and learning of mathematics. The NCTM (1990) have recently published their annual yearbook which is entitled Teaching and Learning Mathematics in the 1990s. This book supplies 28 articles related to some of the newer techniques and implications of teaching and learning mathematics. Applying these very recent revelations to my study, the blunt question "Is this program just designed to get students through academic mathematics or does it have a broader goal"? simply must be raised. Still further, according to Kaplan, Takashi and Finsburg (1989), "The goal of instruction should be to help children interpret formal mathematics concepts and procedures in terms of their informal, invented procedures and in terms of their beliefs about what is expected of them" (p. 64). These scholars hold that the mathematics teacher has to have a clear understanding of the mathematics to be learned as well as the ability to see the mathematics through their student's eyes. If the teacher were able to achieve this, then the instruction would be more

effective for guiding the children.

With this in mind, I may well have used differently the 25-item test developed by myself. It could have been used as a diagnostic device, to see just where these students made the most errors. This could then have helped provide information to their teachers as to areas where more remediation could be given. In effect, it could then have become a diagnostic device. Perhaps better still a more appropriate standardized diagnostic test could be selected that would help diagnose the needs of these students. Only one of the teachers interviewed reported having used a diagnostic test at the beginning of the school year to help find the weaknesses of her students.

Reflecting upon the interviewing of the teachers involved with this program as well as in watching the videotaped lessons, it became apparent to this researcher that much of the extra time was used for a slower-paced instruction as well as for more drill and practice of the topics covered in class. According to Resnick and Ford (1981), "drill and practice as a supplement to instruction ... may be of immense help from time to time for certain students" (p. 34). However, they also claim that much is unknown about the effects of drill and practice on children's learning and thinking. Therefore, they feel that "more precise indications of the value and effects of drill and practice are necessary in order to define its proper role in mathematics instruction" (p. 35). This factor alone could provoke an entire sustained evaluation.

Having spent four years attempting to evaluate this program, I realize now that it was an ambitious undertaking. I discovered that it is indeed a difficult task to attempt to evaluate a full year's program. With a better understanding of the many factors that can play a part in the learning of mathematics as well as an additional awareness of the nature of mathematics itself, I realize now that it was difficult to take into consideration even a majority of the many factors that can play a role in a student's understanding of mathematics. To glean a more adequate notion of the actual impact of extra time, at least one specific topic or unit should have been investigated in some depth. A smaller group of students could have been analyzed. In this manner, more detail could have been obtained concerning these students and a more careful monitoring of the allocated time could have been done for the smaller group.

Factors other than that of allocated time could have played a role in determining the achievement of these students. The amount of homework completed, the personality and competence of the teachers involved, the attendance of the individual students, how the time was actually spent-to name a few-would all play a part when one considers the achievement of the students.

Recommendations

The following recommendations are based upon the review of the literature and the findings of this study.

1. If the study is to be replicated, consideration should be given to the closer inspection of a more restricted population, with more emphasis to be placed on a specific topic as it relates to the actual time allocated to that topic.

2. More emphasis should be placed on the quality of the instruction as it relates to the very latest information about mathematical thinking as opposed to the time used for instruction.

3. If possible, a case study could be done, with a more meticulous monitoring of how the time is spent, this done to obtain information about how much time is needed for these students to learn a given topic as compared to students of a higher demonstrated ability.

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APPENDIX A**Sandman Math Attitude Inventory**

Sandman MAI**Key:**

	1	2	3	4
	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Mathematics is useful for the problems of everyday life.	1	2	3	4
2. Mathematics is something which I enjoy very much.	1	2	3	4
3. I like the easy mathematics problems best.	1	2	3	4
4. I don't do very well in mathematics.	1	2	3	4
5. My math teacher shows little interest in the students.	1	2	3	4
6. Working mathematics problems is fun.	1	2	3	4
7. I feel at ease in a mathematics class.	1	2	3	4
8. I would like to do some outside reading in mathematics.	1	2	3	4
9. There is little need for mathematics in jobs.	1	2	3	4
10. Mathematics is easy for me.	1	2	3	4
11. When I hear the word mathematics, I have a feeling of dislike.	1	2	3	4
12. Most people should study some mathematics.	1	2	3	4
13. I would like to spend less time in school doing mathematics.	1	2	3	4
14. Sometimes I read ahead in our mathematics book.	1	2	3	4
15. Mathematics is helpful in understanding today's world.	1	2	3	4
16. I usually understand what we are talking about in math class.	1	2	3	4

	1	2	3	4
	Strongly Agree	Agree	Disagree	Strongly Disagree
17. My mathematics teacher makes mathematics interesting.	1	2	3	4
18. I don't like anything about mathematics.	1	2	3	4
19. No matter how hard I try, I cannot understand mathematics.	1	2	3	4
20. I feel tense when someone talks to me about mathematics.	1	2	3	4
21. My mathematics teacher presents material in a clear way.	1	2	3	4
22. I often think, "I can't do it," when a math problem seems hard.	1	2	3	4
23. Mathematics is of great importance to a country's development.	1	2	3	4
24. It is important to know mathematics in order to get a good job.	1	2	3	4
25. It doesn't disturb me to work mathematics problems.	1	2	3	4
26. I would like a job which doesn't use any mathematics.	1	2	3	4
27. My math teacher knows when we are having trouble with our work.	1	2	3	4
28. I enjoy talking to other people about mathematics.	1	2	3	4
29. I like to play games that use numbers.	1	2	3	4
30. I am good at working mathematics problems.	1	2	3	4
31. My mathematics teacher doesn't seem to enjoy teaching math.	1	2	3	4
32. Sometimes I work more math problems that are assigned.	1	2	3	4

	1	2	3	4
	Strongly Agree	Agree	Disagree	Strongly Disagree
33. You can get along well in every day life without mathematics.				1 2 3 4
34. Working with numbers upsets me.				1 2 3 4
35. I remember most of the things I learn in mathematics.				1 2 3 4
36. It makes me nervous to even think about doing mathematics.				1 2 3 4
37. I would rather be given the right answer to a math problem than to work it out myself.				1 2 3 4
38. Most of the ideas in mathematics aren't very useful.				1 2 3 4
39. It scares me to have to take mathematics.				1 2 3 4
40. My mathematics teacher is willing to give us individual help.				1 2 3 4
41. The only reason I'm taking mathematics is because I have to.				1 2 3 4
42. It is important to me to understand the work I do in math.				1 2 3 4
43. I have a good feeling toward mathematics.				1 2 3 4
44. My mathematics teacher knows a lot about mathematics.				1 2 3 4
45. Mathematics is more of a game than it is hard work.				1 2 3 4
46. My math teacher doesn't like students to ask questions.				1 2 3 4
47. I have a real desire to learn mathematics.				1 2 3 4
48. If I don't see how to work a math problem right away, I never get it.				1 2 3 4

APPENDIX B
Student Questionnaire

Appendix B
Student Questionnaire

PURPOSE: This survey is intended to obtain some information about academic mathematics and its students. Please be assured that your name will not be used in any way.

1. Name _____
2. Name of school in which you completed grade 9 _____
3. Mark you received in mathematics at the end of grade 9 _____

INSTRUCTIONS: Please answer each question as carefully as possible by circling your response. For responses which require estimates, please give the closest estimate possible.

4. Sex
 - a) M
 - b) F
5. Which mathematics course are you presently studying?
 - a) Mathematics 1203
 - b) Mathematics 2203
6. How many mathematics class periods are you assigned during a six-day cycle?
 - a) Six
 - b) Nine
7. What was your average mark in mathematics last year?
 - a) 80 or more
 - b) 65 - 79
 - c) 55 - 64
 - d) 50 - 54
 - e) less than 50

8. On the average, how much time do you spend on your mathematics homework when you are assigned homework?
- a) Less than 15 minutes
 - b) Between 15 and 30 minutes
 - c) More than 30 minutes
9. On the average, how much time do you spend on all of your homework each night (consider the weekend as one night)?
- a) Less than 1 hour
 - b) Between 1 and 2 hours
 - c) More than 2 hours
10. Approximately how many mathematics classes have you missed this year?
- a) Fewer than 5
 - b) Between 5 and 10
 - c) Between 10 and 20
 - d) More than 20
11. If you are having trouble with mathematics, to whom are you most likely to look for help?
- a) Parents or guardians
 - b) Teachers
 - c) Friends
 - d) Relatives or other adults outside your home
12. Is there anyone at home who can help you with problems in mathematics?
- a) Yes
 - b) No
13. Do your parents or guardians check to see that your homework is completed?
- a) Sometimes
 - b) Always
 - c) Never

APPENDIX C
Two 25-Item Tests

NAME: _____

Mathematics 1203

Provide the answer only to the following questions. The questions represent the range of topics that you covered this year in your mathematics course. You may use scrap paper to help you determine the answers.

1. Write the equation $2x - 3y = 6$ in the slope-y-intercept form. 1. _____
2. What is the slope of the line $y - 4x + 6 = 0$. 2. _____
3. Find the slope of the line joining the points $(-3, 2)$ and $(-1, 5)$. 3. _____
4. The slope of any horizontal line is _____. 4. _____
5. The slope of a line is 2 and the coordinates of a point on this line are $(2, -1)$. Find the equation of the line in slope-intercept form. 5. _____
6. Solve for y: $-2y - 6x < 2$ 6. _____
7. Find the value of c so that the slope of the line through $(c, 5)$ and $(1, 3)$ is 2. 7. _____
8. Subtract $(4y + 6)$ from $(8y - 2)$. 8. _____
9. Multiply: $(x + 2)$ by $(x - 4)$. 9. _____
10. Simplify: $\frac{19y^3 5^2}{-38y5^3}$ 10. _____
11. Simplify: $\frac{(3mn^2)^3}{(-2m^2n)^2}$ 11. _____
12. Express $3^{-2} \times 3^{-3}$ without negative exponents. 12. _____
13. Simplify: $\frac{6x^2 + 14x}{2x}$ 13. _____
14. Find the GCF of 14 and 22. 14. _____

15. Factor: $a^2 - 16$

15. _____

16. Factor: $9x^2 - 6x - 8$

16. _____

17. What term must be added to $x^2 - 14x + \underline{\hspace{1cm}}$ to complete a perfect square trinomial.

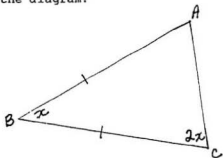
17. _____

18. Solve for x : $x^2 + 7x + 12 = 0$

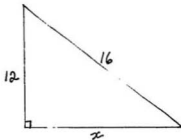
18. _____

19. Find the measure of angle B in the diagram.

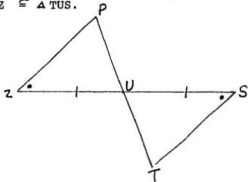
19. _____

20. Find the value of x in the diagram.

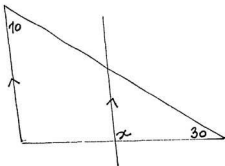
20. _____

21. Using the diagram, state why $\triangle PUZ \cong \triangle TUS$.

21. _____



22. Find the value of x in the diagram. 22. _____



23. Two angles of a triangle are 50° and 80° . What type of triangle is it? 23. _____
24. A polygon has 10 sides. What is the sum of the measures of its interior angles? 24. _____
25. If a pair of opposite sides of a quadrilateral are equal and parallel then the quadrilateral is a _____. 25. _____

NAME: _____

Mathematics 2203

Provide the answer to the following questions. The questions cover the topics you covered in your mathematics course this year. You may use scrap paper to help you determine the answers. Give the answer in the spaces provided.

1. Simplify: $\frac{m+3}{m^2-9}$

1. _____

2. Multiply and simplify:

$$\frac{5m^2}{n} \times \frac{4n}{3m}$$

2. _____

3. What value must be excluded from the replacement set of

$$\frac{3x}{2x+6}$$

3. _____

4. Divide and Simplify:

$$\frac{x^2-16}{x^2-25} \div \frac{x+4}{x+5}$$

4. _____

5. Add and Simplify:

$$\frac{x+2}{2} + \frac{x-1}{6}$$

5. _____

6. Solve for x:

$$\frac{4}{x} + \frac{3}{2x} = \frac{11}{2}$$

6. _____

7. Simplify: $\sqrt[3]{-64a^3}$

7. _____

8. Simplify: $\sqrt{18} + \sqrt{8}$

8. _____

9. Simplify: $\frac{\sqrt{3}}{5}$

9. _____

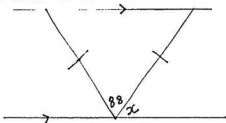
10. Simplify: $(1+\sqrt{2})^2$ 10. _____
11. Solve for r: $5^r = \frac{1}{125}$ 11. _____
12. Simplify using complex numbers:
 $\sqrt{9}x\sqrt{-4}$ 12. _____
13. Multiply and simplify using complex numbers:
 $(3 + 2i)(4 - i)$ 13. _____
14. The system of equations
 $y = x - 5$
 $2y = x - 10$
will have (how many) solutions. 14. _____
15. Solve the system:
 $x = 2y$
 $x + 3y = 10$ 15. _____
16. Solve the system:
 $2x + y = 12$
 $3x + y = 17$ 16. _____
17. Susan rides her bicycle 18 km with the wind in 2 h. It takes her 3 h to return against the wind. What is Susan's riding speed? 17. _____
18. What is the slope of a line perpendicular to the line $2x + 3y = 6$ 18. _____
19. Find the distance AB between points A(6,2) and B(-3,1) 19. _____
20. What is the equation of a line through the x-intercept 4 and parallel to the line $x + 2y = -4$ 20. _____
21. In $\triangle ABC$, angle A is 20° more than angle C and angle B is 20°

more than angle A. Find the measures of the three angles of the triangle.

21. _____

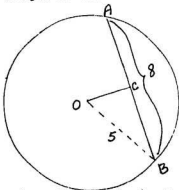
22. Using the diagram below, find the value of x .

22. _____



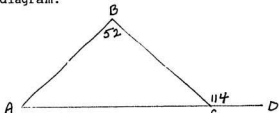
23. In the given circle with center O , find the length of OC .

23. _____



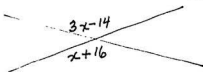
24. Find the value of angle A, in the diagram.

24. _____



25. Find the value of x , using the diagram.

25. _____



APPENDIX D**Answer Keys for 25-Item Tests**

NAME: _____

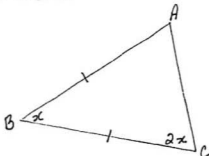
Mathematics 1203

Provide the answer only to the following questions. The questions represent the range of topics that you covered this year in your mathematics course. You may use scrap paper to help you determine the answers.

- | | |
|--|---|
| 1. Write the equation $2x - 3y = 6$ in the slope-y-intercept form. | 1. <u>$y = \frac{2}{3}x - 2$</u> |
| 2. What is the slope of the line $y - 4x + 6 = 0$. | 2. <u>4</u> |
| 3. Find the slope of the line joining the points $(-3, 2)$ and $(-1, 5)$. | 3. <u>$\frac{3}{2}$</u> |
| 4. The slope of any horizontal line is _____. | 4. <u>0</u> |
| 5. The slope of a line is 2 and the coordinates of a point on this line are $(2, -1)$. Find the equation of the line in slope-intercept form. | 5. <u>$y = 2x - 5$</u> |
| 6. Solve for y: $-2y - 6x < 2$ | 6. <u>$y > -3x - 1$</u> |
| 7. Find the value of c so that the slope of the line through $(c, 5)$ and $(1, 3)$ is 2. | 7. <u>2</u> |
| 8. Subtract $(4y + 6)$ from $(8y - 2)$. | 8. <u>$4y - 8$</u> |
| 9. Multiply: $(x + 2)$ by $(x - 4)$. | 9. <u>$x^2 - 2x - 8$</u> |
| 10. Simplify: $\frac{19y^3 5^2}{-38y5}$ | 10. <u>$\frac{y^2}{-25}$</u> |
| 11. Simplify: $\frac{(3mn^2)^3}{(-2m^2n)^2}$ | 11. <u>$\frac{27n^2}{4m}$</u> |
| 12. Express $3^{-2} \times 3^{-3}$ without negative exponents. | 12. <u>$\frac{1}{3^5}$ or $\frac{1}{243}$</u> |
| 13. Simplify: $\frac{6x^2 + 14x}{2x}$ | 13. <u>$3x + 7$</u> |
| 14. Find the GCF of 14 and 22. | 14. <u>2</u> |

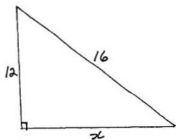
15. Factor: $a^2 - 16$
16. Factor: $9x^2 - 6x - 8$
17. What term must be added to $x^2 - 14x + \underline{\hspace{1cm}}$ to complete a perfect square trinomial.
18. Solve for x : $x^2 + 7x + 12 = 0$
19. Find the measure of angle B in the diagram.

15. $(a+4)(a-4)$
16. $(3x-4)(3x+2)$
17. $\underline{49}$
18. $\underline{\{-3, -4\}}$
19. $\underline{36}$



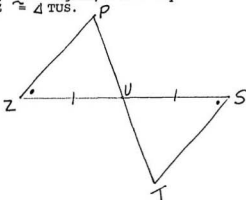
20. Find the value of x in the diagram.

20. $\underline{\sqrt{112} \text{ or } 10.6}$

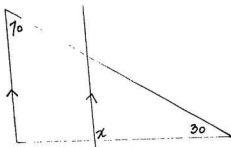


21. Using the diagram, state why $\triangle PUZ \cong \triangle TUS$.

21. \underline{ASA}



22. Find the value of x in the diagram. 22. 80



23. Two angles of a triangle are 50° and 80° . What type of triangle is it? 23. isosceles
24. A polygon has 10 sides. What is the sum of the measures of its interior angles? 24. 1440
25. If a pair of opposite sides of a quadrilateral are equal and parallel then the quadrilateral is a _____. 25. parallelogram

NAME: _____

Mathematics 2203

Provide the answer to the following questions. The questions cover the topics you covered in your mathematics course this year. You may use scrap paper to help you determine the answers. Give the answer in the spaces provided.

1. Simplify: $\frac{m+3}{m^2-9}$

1. $\frac{1}{m-3}$

2. Multiply and simplify:

$$\frac{5m^2}{n} \times \frac{4n}{3m}$$

2. $\frac{20m}{3}$

3. What value must be excluded from the replacement set of

$$\frac{3x}{2x+6}$$

3. -3

4. Divide and Simplify:

$$\frac{x^2-16}{x^2-25} \div \frac{x+4}{x+5}$$

4. $\frac{x-4}{x-5}$

5. Add and Simplify:

$$\frac{x+2}{2} + \frac{x-1}{6}$$

5. $\frac{4x+5}{6}$

6. Solve for x:

$$\frac{4}{x} + \frac{3}{2x} = \frac{11}{2}$$

6. 1

7. Simplify: $\sqrt[3]{-64a^3}$

7. $-4a$

8. Simplify: $\sqrt{18} + \sqrt{8}$

8. $5\sqrt{2}$

9. Simplify: $\frac{\sqrt{3}}{5}$

9. $\frac{1}{5}\sqrt{15}$ or $\frac{\sqrt{15}}{5}$

10. Simplify: $(1+\sqrt{2})^2$ 10. $3+2\sqrt{2}$

11. Solve for r: $5^r = \frac{1}{125}$ 11. -3

12. Simplify using complex numbers:

$$\sqrt{9}x\sqrt{-4}$$

12. $6i$

13. Multiply and simplify using complex numbers:

$$(3 + 2i)(4 - i)$$

13. $14 + 5i$

14. The system of equations

$$\begin{aligned} y &= x - 5 \\ 2y &= x - 10 \end{aligned}$$

will have (how many) solutions.

14. one

15. Solve the system:

$$\begin{aligned} x &= 2y \\ x + 3y &= 10 \end{aligned}$$

15. $(4, 2)$

16. Solve the system:

$$\begin{aligned} 2x + y &= 12 \\ 3x + y &= 17 \end{aligned}$$

16. $(5, 2)$

17. Susan rides her bicycle 18 km with the wind in 2 h. It takes her 3 h to return against the wind. What is Susan's riding speed?

17. 7.5

18. What is the slope of a line perpendicular to the line $2x + 3y = 6$

18. $\frac{3}{2}$

19. Find the distance AB between points A(6, 2) and B(-3, 1)

19. $\sqrt{82}$ or 9.1

20. What is the equation of a line through the x-intercept 4 and parallel to the line $x + 2y = -4$

20. $y = -\frac{1}{2}x + 2$
or $y = -\frac{1}{2}(x - 4)$

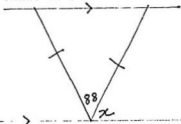
21. In $\triangle ABC$, angle A is 20° more than angle C and angle B is 20°

more than angle A. Find the measures of the three angles of the triangle.

21. 40, 60, 80

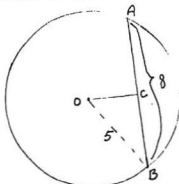
22. Using the diagram below, find the value of x .

22. 46



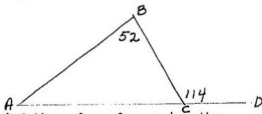
23. In the given circle with center O , find the length of OC .

23. 3



24. Find the value of angle A , in the diagram.

24. 62



25. Find the value of x , using the diagram.

25. 15

