THE CONTENT FOR A NON-UNIVERSITY-PREPARATORY MATHEMATICS PROGRAM FOR GRADES 9, 10, AND 11 AS PERCEIVED BY MATHEMATICS TEACHERS IN THE HIGH SCHOOLS AND TRADES SCHOOLS IN NEWFOUNDLAND

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by

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A Thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Education

Department of Curriculum and Instruction
Memorial University of Newfoundland
November 1979

St. John's Newfoundland

Abstract

This study was designed primarily to compare the perceptions of the high school teachers of mathematics and the trades school teachers of mathematics in Newfoundland concerning content items for a non-university-preparatory mathematics program for grades 9, 10, and 11. Ninety items were used in the study. They were placed in categories A - Performing operations on given number systems, B - Recognizing properties of these number systems, C - Arithmetic Computation, D - Number Theory, E - Algebra, F - Geometry, G - Trigonometry, H - Measurement, I - Statistics, J - Business and Consumer Mathematics, and K - Logic. These items were randomly placed on two questionnaires which were of identical format. Each contained 45 items.

High school mathematics teachers greatly outnumber trades school mathematics teachers so each of the latter was asked to complete both questionnaires while each of the former was asked to complete one. Each teacher was asked to rank three given aims for the proposed program in order of perceived importance. Based on these rankings, they were asked to rate each content item on a scale of 1 to 5. These numbers suggested a range of views from recommending that an item definitely should be included in this program to its definite exclusion from the program. The aims of the program, in brief, were to provide a program which would (1) prepare students for everyday living, (2) prepare students

to enter the workforce and one-year courses of studies at trades schools, and (3) provide remedial work for students having difficulties with mathematics. In addition, each teacher was given the opportunity to suggest any other aims for the program and to state his views on the need for such a program.

Based on the given rankings of the proposed aims, the teachers were subgrouped and the perceptions of these subgroups were studied and compared. An index for each content item was tabulated for each group and each subgroup of teachers. In addition, a recommendation relative to the inclusion of each item in the program was determined from these indices.

It was concluded that, in general, teachers felt that the major aim for such a mathematics program is to prepare students to enter the workforce and trades school immediately after leaving grade 11. High school teachers indicated a concern with teaching non-university-bound students topics from business and consumer related mathematics. Trades school teachers were chiefly concerned with topics from arithmetic computation, but were more concerned than high school teachers with the need to include algebra in the program.

Neither the high school teachers nor the trades school teachers placed much importance on logic, the recognition of mathematical properties, or statistics. They considered statistics as least in importance. However, both groups wanted the inclusion of performance of operations, arithmetic computation, geometry, measurement, and business and consumer mathematics. The trades school teachers seemed inclined to include more algebra in the program with the aims as given than did the high school teachers.

Comparisons of the opinions of subgroups of the high school and the trades school teachers were made. These subgroups were identified by the ways these teachers ranked the aims of the program according to their perceived orders of importance. There were three such groups. The analysis showed many similarities in the views of these groups as compared with the whole groups of high school and trades school teachers. Many teachers, in the statements of their personal opinions, indicated that there was a definite need in Newfoundland high schools for a program which was designed along the ideas presented by the aims of the program in this study.

Acknowledgements

The writer would like to thank all those who played any part in the completion of this study; namely, the teachers of mathematics from the high schools and the trades schools involved, instructors and advisors at Memorial University of Newfoundland, and the Committee members - Dr. G Wooldridge, Dr. D. Drost and Dr. C. Brown - who participated in the final evaluation of the study.

In particular, I would like to offer deepest gratitude to Dr. Glyn Wooldridge and to Dr. Dale Drost who provided the guidance and suggestions which are greatly appreciated.

In addition, I must thank my wife, Betty, who encouraged me in my work, and my two children, Tracy-Lynn and Kirk, who patiently stood by me, as I spent several summers and many other long hours preparing for the completion of this work.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

During the past quarter of a century many developments have occurred in the field of mathematics. Many individuals, such as E. G. Begle and E. L. Edwards, and many groups, such as the School Mathematics Study Group, the University of Illinois Committee on School Mathematics, and the Commission on Mathematics of the College Entranoe Examination Board, to mention a few, have produced revolutionary work in the mathematics curriculum. Reforms have occurred and are continually occurring. In the 1950's the setting was ripe for dramatic change in the mathematics curriculum. The launching of Sputnik in 1957 made the American government realize the importance of the space age and the potential danger of lagging behind the Soviet Union, so more than ever before, money became available for revisions and improvements in mathematics programs.

In that recent era the "new or "modern" mathematics resulted from the reformation. This mathematics was also revised and reformed in subsequent years. It seemed to many that the new mathematics placed too much emphasis on the "why" and too little on the "how", producing graduates who were undesirably weak in the basic computational skills. The 1970's were entered, as Greenburg (1974) described it, with pressure to swing away from the extremes of the new mathematics and toward a middle ground, acknowledging the need for computational skills as well as for the applications of mathematical concepts. Curriculum changes must and should occur; it is hoped that they are always aimed at the improvement of the education of the student.

A relatively common finding in the schools today is mathematics courses for students of different mathematical abilities and interests. Edwards (1972) suggested that there were three basic ways to view mathematics. These were: (1) Mathematics as a tool for effective citizenship and personal living; (2) Mathematics as a tool for the functioning of the technological world; and (3) Mathematics as a system in its own right.

It is advisable for educators to be aware of the overall view or aim of any mathematics program, particularly considering the above views. Presently, in Newfoundland secondary schools there are three "streams": the Honours stream, the Matriculation stream, and the Basic stream. The rationale and philosophy for such streaming have been published for several years by the provincial Department of Education in the <u>Mathematics Curriculum Bulletin</u> for grades 7 - 11. (See Appendix A). To some degree these three streams reflect the three views presented by Edwards. The Basic, Matriculation, and Honours programs seem related to the first, second and third views, respectively. The compositions of the Honours and Matriculation programs are such that the students capable of going to university should be placed in one of them. Most of the non-university-capable, and mathematically weak, students study the Basic Program. Many students on this program terminate formal study of mathematics in grade eleven while others apply some mathematics in trades school courses.

The three streams described above also bear certain similarities in the teaching and learning of mathematics to the categories suggested by Dodes (1967): (1) Honours - top academic; (2) First Track - regular academic; and (3) Second Track - low ability or poor preparation or low interest or other miscellaneous difficulties. This latter group are not necessarily simply slow learners.

The Honours and First Track streams, as described by Dodes, seem comparable to the Honours and Matriculation streams in Newfoundland secondary schools. The Second Track would include students from the Basic program as well as the 'weaker' students from the Matriculation program.

Most mathematics educators would probably agree that it is easier to make curriculum decisions concerning programs for streams such as the Honours and the Matriculation or First Track streams. In other words, it seems less difficult to devise programs for the university capable student than to do so for the non-university capable. For example, if a person is to major in mathematics at a university it becomes relatively clear what he should be able to do as a result of his high school mathematics, for to a great extent the university curriculum dictates this high school preparation. It may not be quite so easy to design mathematics programs for university-capable students who do not major in mathematics.

It does not seem so easy to do so for the non-university capable student. There exists a difficult problem in deciding whether such a program should emphasize the preparation of the student for effective citizenship and personal living or for functioning in a technological world. Many mathematics educators feel that such students should be taught only the mathematics they will use during their 'consumer' lives. Others feel that they should be taught the mathematics necessary for future technical training. Then there are those who seem to have difficulty in deciding between these two views.

Dodes (1967) stated that, historically, the first question that has been asked in curriculum development of 'general' or non-university-preparatory mathematics is "What do students want?", while the second question usually asked has been "What will students enjoy?". He claimed that both questions have served as poor and, in fact, doomed approaches to making curriculum decisions on two accounts. First, the students do not know what they want and, second, no adult has retained enough wisdom to know what the students enjoy. Dodes continued by saying:

> ... proper question to ask in any course is always: "What do the student need?" It may be difficult or almost impossible to reach a decision about this but it certainly is the professional question. A physician does not ask 'What medicine does the patient want?' nor does he ask "What medicine will the patient enjoy?". He tries to satisfy a need, whether or not the patient thinks he needs it. (p. 248)

Most educators agreed that the conference projects and other work done in the 1960's on the mathematics curriculum provided better mathematics for the university capable student. However, the new program resulting from these efforts did very little for other students. In support of this, Bell (1974) stated that they did not do much to improve mathematics for 'everyman'. Bolliver (1971) made a similar claim. He said that:

> Although the School Mathematics Study Group did begin work in the summer of 1960 on a curriculum project for the less able students Fishman reported in 1965 that the general mathematics curriculum was virtually untouched by the reform.... The University of Illinois Committee on School Mathematics did not begin experimentation with programs other than the college preparatory until 1964-1965. (p. 4)

Historically, very little, and certainly not enough, attention has been given to mathematics programs for the non-university-capable student. In Newfoundland the majority of these students are found in the Basic mathematics program. Some of them may be in the Matriculation program, but they are likely struggling to meet minimum standards. A great deal of concern has been expressed about the content of the non-university-preparatory program. The present study attempted to identify what the mathematics teachers in Newfoundland high schools and vocational schools consider as appropriate content items for a basic mathematics program for grades 9, 10, and 11.

Definitions

1. Non-university-preparatory mathematics: In this study this means a mathematics course which is non-academic; that is, it is not designed to meet university entrance requirements. Its major aims (see the next section) are to prepare students for everyday living and to enter the workforce directly or a one-year course of study at a trades school. The program, in some cases, may serve as remedial material enabling some students to return to an academic program. Throughout the remainder of this report, this program, for convenience, will be frequently referred to as a "general" mathematics program.

2. Non-university-bound (capable) students: This refers to a student who is studying a program such as that described above. Generally, he is not capable of successfully studying an academic program such as the Honors or the Matriculation program. Throughout the remainder of this report, such a student will be referred to as a "general"

mathematics student.

Purposes of the study

The purposes of this study were:

1. To establish, according to the perceptions of concerned groups of mathematics teachers, a list of content items appropriate for a non-university-preparatory mathematics program for grades 9, 10, and 11 in Newfoundland schools.

2. To determine the relative importance of these content items as perceived by the concerned groups, with reference to how the respondents ranked, in order of importance, three aims for the program.

These three aims of the proposed program were developed from the course description of the Basic mathematics program presently used in Newfoundland high schools. The aims were:

(a) Everyday living: to provide a program which emphasizes the practical, social, and computational aspects or skills which are necessary for everyday living.

(b) Vocational: to provide a program which will provide the students with mathematics concepts enabling them to enter the workforce or to begin studies at a vocational or trades school in courses which the Provincial Division of Vocational Education has described as requiring one full year of study.

(c) Remedial: to provide a program which will offer remedial work to students who have experienced difficulties with mathematics and will offer them the opportunity to return to an academic mathematics program (i.e. the present Matriculation program or its equivalent).

Questions investigated by this study

Answers were sought to the following questions:

(i) What content items are recommended for this program by high school teachers? by trades school teachers?

(ii) On what content items is there agreement between the two groups?

(iii) What content items are important (or unimportant) to one group only?

(iv) What content items are important (or unimportant) to subgroups of these two groups of mathematics teachers formed as a result of their rankings of the three aims in order of importance for such a program?

(v) How do the indicated ratings of importance of the content items as perceived by these groups compare?

(vi) Are there any differences in the views of high school teachers relative to their ages, university training, teaching experiences, teaching-grade certificates, and experiences with non-academic mathematics?

Need for the study

Mercer (1975) analyzed the needs of the high school students in Newfoundland as perceived by mathematics instructors at Memorial University of Newfoundland and various vocational and technical schools. That study presented twenty objectives of mathematics which were written in both a low and a high cognitive level. The instructors indicated from these objectives what they felt was suitable for high school students. Mercer's study provided some valuable information for those concerned with preparing objectives for high school mathematics. However, no high school teachers were included in his samples.

The claim was made earlier in this chapter that a program for the general students is not easy to devise and there seem to be differing views as to the content for such a program. In Newfoundland there is a concern among some mathematics educators about the content of the Basic Mathematics program. This program has been designed for students who are not capable of successfully studying an academic program. The researcher had become aware of these concerns from mathematics conferences, meetings, general discussions, and from contacts in parts of the province. There seemed to be a need to study the perceptions of practising mathematics teachers in the high schools and the trades schools of Newfoundland relative to the content of a general program. Dodes (1967) claimed that there should be agreement among teachers of mathematics relative to the content of what he called the Second Track.

It was recognized that it is desirable to have input from many sources in order to make sound curriculum decisions. Two sources which could be tapped were the high school teachers and the trades school teachers. They have received some training in the teaching of mathematics and have studied some post-secondary mathematics courses. With their experiences they had provided points of view which may be quite useful in the development of programs.

Research on this topic is rather limited -- in fact, virtually non-existent -- in Newfoundland. There was a need to determine if high school and trades school teachers agree regarding content items for this type of program so that their views could be available to curriculum decision-makers as they contemplate the composition of programs.

Limitations of the study

Teacher input is a factor in curriculum decision making. This study provided some input for a general mathematics program for Newfoundland secondary schools. A list of content items was recommended for inclusion in such a program. This list was compiled as a result of studying teachers' opinions. It is, however, merely a sample of content items, and there are many other items which would have to be considered for inclusion.

The samples, especially for the high school teachers, did not include all mathematics teachers in the province. This introduced a limitation in that not all opinions are included. Also, information from teachers may lack some validity as some teachers may have based their recommendations on uninformed opinion in that they may not have been familiar with many learning theories and that their experience with selecting and evaluating content may have been limited.

The high schools involved in the study were not selected by random choice. Rather, they were selected by the researcher in an attempt to represent rural and urban schools and larger and smaller schools containing high school students. Schools from most geographical regions of the island were involved. They were selected from among the Integrated, Roman Catholic and Pentecostal school boards. An effort was made by the researcher to avoid any possible personal biases having any influence in the selection. He is unaware of any such influences but recognizes possible limitations due to it.

The collection of the data by means of questionnaires sent through the mail may also introduce a limitation. Some teachers may have had difficulty in rating some items using the scale provided. If so, this could affect the validity of some of the analysis as no personal contact was made.

The opinions expressed by the teachers involved in the study may have reflected their personal biases. Some, for varying reasons, may have been biased toward the academic programs while others may have been biased toward the non-academic programs.

Another limitation may have been introduced when the respondents were told that the study dealt with a program for grades 9, 10, and 11, but they were not told at which of these grade levels any items should be introduced, nor whether its development should be complete in one section or developed spirally. They were simply asked to consider content appropriate for these high school grades.

It is not suggested that the content items involved in this study constitute an exhaustive list, nor that they alone should be the composition of any mathematics program. It is also recognized that the opinions of high school and trades school teachers should not alone determine the direction of curriculum planning. Nevertheless, the study does provide a core of information that may be useful and desirable to know when making curriculum decisions.

Outline of the report

The remaining chapters of this report attempt the fulfil the stated purposes and to answer the proposed questions. Chapter II summarizes the review of literature dealing with the development of non-university-preparatory mathematics programs. The literature is presented in three sections which have been arranged chronologically. These eras are the pre-1920's, 1920 - 1945, and 1945 to the present.

In Chapter III the design of the study is presented. The method used for selecting the content items for the study and the instruments used to collect the data are described. The study populations and the samples are defined and the method of analysis is described.

Chapter IV provides the analysis of the data and summarizes the findings, both in written and tabular forms.

Chapter V deals with the study in retrospect. It highlights the major findings, states the major conclusions and gives some implications resulting from the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

In this chapter the history of the development of general mathematics programs is traced. The discussion of the pre-1950 programs is relatively short due to the fact that very little work was done on this type of mathematics program during those years. Most of the related literature had been written within the past quarter of a century. Therefore, a greater emphasis in this chapter is placed on the views, works, and comments of groups and individuals concerned with the general student during that time. The post 1945 era material is divided into two section; one deals with objectives for programs for these students and the other deals with types of programs and content.

Pre-1920

In 1911 the College Entrance Examination Board was established in the United States. This Board had a very strong influence on the secondary school mathematics curriculum during this era. This influence generally tended to stress the university preparatory programs. It particularly advocated concrete geometry and introductory algebra as early as the seventh grade. During this time there was mounting pressure to provide an education for all children. In 1916, the National Committee on Mathematics Requirements was appointed in the United States. It advocated a general mathematics program for grades seven to nine which would include topics from arithmetic, algebra, intuitive geometry, numerical trigonometry, graphs, and descriptive statistics (Jones and Coxford, 1970). Despite this recommendation of a more general mathematics course, the pre-1920 era was mainly one which stressed the university preparatory mathematics curriculum for the secondary schools.

<u>1920 - 1945</u>

This was a period of great unrest in the social world as there was a great depression and a world war, both of which had profound effects on education. Early in the 1920's the junior high school became an established sector of the schooling process. These schools were turning to the general mathematics concept as advocated by the National Committee on Mathematics Requirements. This Committee, in a report, stated that they found no conflict between the needs of the college preparatory students and those of the non-college-aspiring students (Jones and Coxford, 1970, p. 47). Thus, the Committee which remained in effect until 1923 reinforced the college-preparatory orientation of the mathematics curriculum.

Many people in the 1920's started to support the concept of general mathematics as described by the National Committee on Mathematics Requirements. This general mathematics was not a social or a 'practical' mathematics, but its topics were from 'pure' mathematics. In spite of this, for the grades above grade eight, the general mathematics programs were never generally accepted. As the 1930's and the depression set in, more and more people became disgruntled with the utility, or lack of it, of such mathematics. Wilson (1960) described the situation this way:

> In the thirties, we tried general mathematics - an integration of old-fashioned algebra and geometry with some arithmetic and trigonometry. But this effort did not meet with favour; the climate of opinion was not right. In those depression days of the thirties we could not justify mathematics 'for its own sake'; we had to show that the subject was useful in daily life activities. And this the early courses in general mathematics did not do. (p. 520)

The socio-economic conditions brought greater pressures for change on the mathematics curriculum. Jones and Coxford (1970) reported that

> the pragmatism of John Dewey and others led to a heavy stress on utility as a goal of education. This in turn led to numerous investigations of the occurence of mathematics in newspaper and magazine reading, in student activities. The conclusion was that many topics had little or no utility for the general student. In other words, the school mathematics, especially as taught in grades seven to twelve, was under rather severe attack. (p. 48)

This attack continued in the 1930's and the 1940's. There developed a 'socialization' or a demand for 'consumerism' in the mathematics curriculum, especially in the general mathematics. Jones and Coxford (1970, p. 69) pointed out that the Commission on Post War Plans, appointed in 1944, made several recommendations concerning the mathematics program. Among these were the need for (1) a functional competence on the part of all graduates, (2) a two-track system, (3) mathematics in general education, and (4) mathematics in consumer education. Furthermore, this Commission, as Harding (1968) reported, suggested a list of twenty-nine competencies for all who could attain them. Of these competencies, four involved arithmetic skills and operations; seven measurement and approximation; four algebraic skills and concepts; six geometric ideas; three graphs, tables, and statistics; three applications; and two deductive reasoning.

However, these reforms in mathematics were slow in coming. Boliver (1971, p. 2) stated that these general mathematics courses flourished throughout the period between World War I and World War II, but they were largely ignored by organizations of mathematics teachers and mathematicians. In conclusion, it may be said that because of effects of the Great Depression and World War II and the resistance to change by teachers and administrators, there was a general failure to make the needed reforms during this period.

1945 - Present

The pressures for reform of the prewar and wartime period still continued and had their impact. After the war other pressures were added when emphasis was placed on cultural aspects of mathematics and on a highly academic level of mathematics to meet the needs of industry, defence and, in the 1950's, space programs. There were demands that the high school mathematics program be advanced and accelerated so that students beginning studies at a university could do so at a level beyond that which had been the existing standard.

Committees such as the School Mathematics Study Group and the University of Illinois Committee on School Mathematics came to have a powerful influence on the mathematics curriculum. Jones and Coxford (1970) stated it:

> ... is still true that the greatest concern and greatest change had been made in the program for the average and superior college-bound students. Of course the elementary and junior high school programs were intended for all students but even here less consideration had been given to the slower students. Beyond the ninth grade, there had not been any general discussions of programs for the non-college-bound students. (p. 79)

During the 1950's, more than ever before, the focus of attention was placed on the general students. In 1959, the School Mathematics Study Group formed a panel of educators and mathematicians to plan a program for students of average and below average mathematics ability. However, the early work of this group (i.e. the SMSG) was for college-preparatory courses. Sobel (1967, p. 11) pointed out that the authors of the textbooks for this program indicated that the material offered was not actually appropriate for the very slow non-college-bound student. Rather it was hoped that the program would awaken the interest of students who may have had unrecognized and undeveloped ability in mathematics and whose progress may have been blocked through an inappropriate program. The NACOME Report (1975) further stated that the

> ... original SMSG secondary school courses were designed for college capable students. But several subsequent investigations indicated by slowing the pace of instruction the same ideas could be learned as well by less able students. For a short time, general mathematics texts incorporated the content innovations of more high powered courses and reports of success were common. (p. 32)

Yet concern over the absence of a good mathematics program for the slow learner resulted in the emergence of some group efforts in the 1960's. In 1964, two conferences were designed specifically to discuss this type of student and his dilemma. One, a joint effort of the Unted States Office of Education and the National Council of Teachers of Mathematics (NCTM), was held in Washington, D.C., in March, 1964. The other was held in Chicago, Illinois, in April, 1964, by the School Mathematics Study Group. These two conferences and the availability of Federal money through the Elementary and Secondary Education Act of 1965 provided the impetus for the gradual appearance of mathematics programs for the low-achieving students on the traditional programs. Begle, at a conference on mathematics for below average achievers (SMSG, 1964), in the introduction to the SMSG Conference stated:

> From the beginning SMSG recognized perfectly well that we were doing something for only part of the school population. We have made a remarkable amount of progress, but we are now far enough along to realize that the rest of the school population, the students who are not doing well in mathematics, must be given attention. (p. 1)

Such was the state of affairs for the low-achieving students in the mid-1960's. Some of the recommendations made to SMSG at this conference were:

1. There was a consensus that the three assumptions often made with respect to the pupil of low ability should be rejected. These assumptions were: (a) That the program for the pupil of low ability should be founded on drill. (b) That the low ability child should not be required to think. (c) That any program for the low ability students should involve little or no reading.

2. It was suggested that any materials prepared must help improve as well as make demands on the student's ability to read.

3. Increased emphasis in secondary school should be upon motivating the pupil's learning of mathematics.

4. Courses should be similar to the courses for high ability pupils. One effort should be to reduce the problem of discrepancies in social prestige. (p. 125)

Determining objectives for non-university-preparatory mathematics programs

In the 1960's it was recognized that it was time to face up to the problem of mathematics for the general students, including the low-achieving and low ability students. Once this was recognized, it did not take long to see that it was going to be a very difficult task to handle. One major task to be identified was the set of objectives for a general mathematics course. There was a need to state the broad goals of instruction with a minimum of vagueness. Watson (1972) stated that the goals of all mathematics instruction are:

> 1. The student understands basic mathematics concepts, operations, and relationships and has acquired the skills in manipulation and computation necessary for his vocational needs, intelligent citizenship, and daily living in our society.
>
> 2. The student understands the nature of mathematics and appreciates the ability of human intelligence to invent and discover mathematical relationships whose applications permit man to understand, influence and order his environment.
>
> 3. The student has gained understanding and skill in using mathematical processes to interpret situations in physical and intellectual environments mathematically, applying the model and testing the relevancy.
>
> 4. The student has the familiarity with the internal nature of mathematics acquired by discovering the relationships and deducing abstractions in mathematics using logical influences.
>
> 5. The student can communicate with precise mathematical language.
>
> 6. The student has gained the independence in learning mathematics and in reading mathematics literature.

> 7. The student enjoys and has appreciation of intellectual pursuits and has imaginative thinking. (p. 475-6)

Watson did point out that the extent to which an individual is expected to attain each of these goals is dependent upon his interest and ability. He said that it

> ... is important in curriculum planning to allow students to attain to some extent each of the goals listed. Such a curriculum would require a spiraling of topics and experience where an individual will study mathematics from a broad base attaining the level of sophistication in each goal to which he is capable. (p. 538)

Determining the 'level of sophistication in each goal' to which the general student is capable is a major task in the development of appropriate programs. Many educators would consider that any student who has completed high school mathematics is adequately prepared to function in society in so far as the use of everyday mathematics is concerned. Some writers have referred to such a person as being mathematically literate. Mathematical literacy has been defined in various ways. Alberty (1966) suggested the following as characteristics of a mathematically literate person:

> 1. He understands and utilizes mathematical methods of inquiry in arriving at solutions of individual and social problems. He appreciates the process by which new knowledge in mathematics is produced and he regards truth as tentative and experimental rather than absolute.
>
> 2. He understands and utilizes the concepts pervasive in mathematics in his daily living.

3. He understands and appreciates the increasing role of mathematics in interpreting and improving the culture.

4. He has command of the fundamental mathematical processes and utilizes them in solving individual and social problems. (p. 428)

Forbes (1978) defined mathematical literacy as the ability to solve reasonable simulations of simple real world problems involving counting, measurement, and percent. He emphasized that central to this literacy is the commitment to problem solving and not merely exercise working. (p. 96)

A question to be raised is 'How far along the road to mathematical literacy, as defined by Alberty, can we bring the non-university-bound student?' Greenholz (1968) p. 70) claimed that many of the would-be high school drop-outs are now staying in school because automation is eliminating the unskilled jobs. With more and more of these students remaining in school, this decision of what mathematics they should learn is becoming quite challenging to educators. In order to answer this question, educators needed to settle on some major objectives of, or reasons for, learning any mathematics. However, reasons are numerous and varied.

Schwartz (1974, p. 42) stated that the main reason for learning mathematics, aside from school requirements, is to acquire some tools for handling problems: learning to analyze situations and draw conclusions about them that help shape future actions. Fehr (1974) stated that the mathematics we teach the students today should be:

> ... relevant to their needs in the society of tomorrow in which they will live. To this end we must first of all be concerned with the development of the intellect - the ability to do cognitive thinking. The mathematics should develop the human mind in its capacity to understand and interpret numerical, spatial, and logical situations and to approach problems with a scientific, questioning and analytic attitude. (p. 27)

Many feel that there is a fundamental obligation for the mathematics curriculum to expose all students to the intellectual values of mathematics. Braunfeld (1973) summed this up by stating:

> A student has been shortchanged if after 9 - 12 years of study of mathematics he leaves school with the notion that mathematics consists of a large collection of routine and boring algorithms that enable him to get 'correct' answers to certain, usually contrived, problems. We contend that all children should be introduced to the discipline called mathematics.... We submit that a mathematically illiterate person will have to live his life in a world many of whose fundamental principles are beyond his grasp. Without mathematics a person is culturally deprived. (p. 43)

This view implies that all mathematics courses should be geared to instructing students in as much 'pure' mathematics as they can handle. Boliver (1971) found that mathematicians have a stronger preference than teachers for objectives which appear to be most closely related to the traditional college preparatory algebra and geometry. Teachers have a stronger preference than mathematicians for those objectives related to reteaching computational skills and social mathematics. Relative to computational skills, those attending the Cambridge Conference on School Mathematics (<u>Goals for School Mathematics</u>, 1963) declared that they were definitely opposed to the view that the main objective is proficiency in arithmatic calculation and said that algebraic manipulation is essential to the study of mathematics. Scheffler (1976) said that even though calculations is very important to mathematics, it is not mathematics and "the great gulf between mere calculations and problem solving occurs within the subject, not beyond it". (p. 209)

The above exemplifies the arguments as to the direction that mathematics should take. These arguments seem amplified when it comes to determining the objectives and content for mathematics programs for the general students. Essentially, there are two factors: one which supports the idea of training these students for specific roles and 'everyday' life while the other argues for educating them, to their full potential, from the discipline of pure mathematics. Concerning this, Forbes (1972) stated that:

> Training is narrow but detailed. Education is broad with less detail. Training is timely; education is timeless... I believe we must make an honest effort to stop wasting a student's time by 'training' him as if he were going to spend his working life doing long-division problems - or factoring quadratics - or getting paid by the problem. (p. 477)

Types of programs and content

There have been many different views expressed concerning mathematics for the general student: many programs have been suggested and tried. Johnson and Rising (1967) suggested that there are four basic types of general mathematics courses:

1. A course that reteaches computational skills.

2. A course that teaches the good mathematics of the college preparatory courses but teaches it at a slower pace, with more concrete examples, less stress on precise language and simpler problems.

3. A course organized around a vocational area, such as shop mathematics, business mathematics, nursing mathematics, or mathematics for home economics.

4. A course built around the mathematics which the learner will need as a citizen, a worker, a consumer.

Boliver (1971, p. 5) stated that in his opinion the majority of general mathematics courses fall into some combination of these courses. Quite a bit of literature relative to this whole area is opinionated; that is, one finds many articles expressing the views and suggestions of the writers. The remainder of this chapter will deal with such views.

Dodes (1967), in his discussion on the "Second Track" stream, made some comments concerning courses set up along the lines as identified by Johnson and Rising, or some combination of these categories. The following is typical of what he said:

> 1. Diluted Algebra and Geometry: These courses are in effect the regular academic courses watered down... These courses are defensible when the difficulty lies in preparation and ability, and when there is a chance that the student will continue in mathematics after the upgrading procedure. Some general mathematics courses are, in reality, diluted ninth grade algebra and tenth grade geometry with the minimum skill requirement and even less concept requirement. These are indefensible.
>
> 2. Rehabilitation Courses: These are the hodgepodge ad hoc courses... shored up with some skills and minor concepts from the regular academic courses... In my mind, I call this 'Advanced Sandbox'.
>
> 3. Remedial Courses: Nothing good can be said about remedial courses... There is absolutely no reason to believe that students who did not learn by some approach the first time will learn by the same approach the second, third or nth time.
>
> 4. Accounting and Bookkeeping Courses: These courses arose when departments of mathematics confessed failure and turned to the business department... All of this may be useful, particularly taught by a person who knows something about them other than the bare arithmetic, but none will claim that it is mathematics. In effect, this move deprived the student of an important facet of our culture - mathematics. (p. 248 - 249)

Those supporting the views of Dodes would suggest that the mathematics taught to the general student should be taken directly from the discipline of pure mathematics but that it should differ in degree and kind from the university preparatory mathematics programs. Opponents of these views would argue that mathematics for the general student should be designed as a pre-training course for particular vocations. In 1968, the Newton, Massachuetts, schools offered a general course where Basic Mathematics I and Basic Mathematics II in the sequence were essentially pre-algebra (equivalent to a 'modern' grade seven and eight). Consumer mathematics for seniors only - a half-year course offerred each semester - contained the social applications of remedial arithmetic needed to solve everyday problems of the adult in our society. Ferguson (1968) stated that the basic philosophy of this was that

> .... a course must be available to any student each year he is in high school, no matter what his level of ability and achievement in mathematics. They planned for courses which contained as much structure of mathematics as the students could handle but these courses will be slanted toward the practical mathematics used in many apprentice training programs. Hopefully these courses will be taught cooperatively by a mathematician and a shop-man. Plans are to spend possibly two days a week on the 'why' and the structure of mathematics and two days on practise using problems of interest to each student. (p. 59)

The 1960's saw considerable discussion and debate on the type of mathematics for the general student. Many of the proposed and existing programs came under critical analysis. Two specific recommendations made at the SMSG Conference were:

1. Three assumptions, long accepted, regarding the programs for students of low ability should be rejected. These assumptions are; (a) the program should be founded on drill; (b) the children should not be required to think; (c) the program should involve little or no reading.

2. The program should be similiar to courses for the high ability pupils (School Mathematics Study Group, 1964, p. 125-126).

Alberty (1966) suggested some shortcomings of programs including those of the SMSG. She said that such programs did not adequately take into account (1) the kind of individual we want to develop; (2) the two integrated aspects of education - general education and specialized education; and (3) the role of mathematics in our culture and its significance in the life of the individual. (p. 426) She felt there was too much concern for the question 'Can the mathematics be learned?' rather than 'Should everyone learn it?'

In the Goals for School Mathematics, (1963) it was stated that some of the topics proposed for the high school had become part of what everyone should know in order to understand the complex world in which he lives. It suggested that:

> In addition to the basic algebraic skills, an educated person should know about such things as the likelihood of an event, the reliability of statistical reports, rate of change, and averages. The problem of students dropping out enters our consideration now and provisions are made to give those who do leave the mainstream the kind of mathematics that will be useful to them and which will develop in them an appreciation of the structure and power of mathematics. (p. 42)

Some educators disagree with the above as being a necessary part of a mathematics program for the general student. Instead they suggest that such a student should be taught enough mathematics to give minimum competency. Taylor (1978) indicated that if we initiate minimum competence requirements, then we can expect to see more mathematics courses in basic skills and consumer skills. Some arguments prevalent in the 1960's favored such 'socialized' or 'consumer' mathematics programs. O'Beirne (1971) typified the views of many educators concerning the types of programs to offer when he said that

> The dominant objective of school mathematics education should be to make as much insight as possible rub off onto those who will depend on their schooling for all the formal mathematics instruction they will ever have.... Undue stress on applied mathematics - sometimes by allegedly practical advocates - is misguided. The specializations of today will not be those of tomorrow. Those of tomorrow - as yet unknown - will, however be based firmly on some of the pure mathematics of today; and this has to be remembered when we aim to prepare children for their whole life, and not merely for their first job. (p. 23)

O'Beirne and many others advocated that mathematics should be taught, not merely on the ground of its utility purposes in everyday affairs or as a means to a job, but that each student should be given the mathematical ideas and principles which govern the world. Boliver (1971) reported that a survey of industries in Jamestown, New York, was conducted to identify the mathematical concepts needed by the workers in order to set up a program. The recommendations of this study came under criticism. However, Boliver pointed out that there were at least two fallacies to the status-quo approach. They were:

> First, industry might require a greater use of mathematics if the workers had greater ability in the subject. Second, when the present pupils are adults, a greater knowledge of mathematics may be demanded of semi-skilled workers than is now the case. (pp. 38 - 39)

Simpson (1957) asserted that the notion of educating a man to adjust him to any particular time or place is foreign to a true conception of education. He continued by saying that:

> The materials and ideas of the present must be used, but the mathematics we teach will deal with basic ideas and processes sure to be of value in the environment of the future... If the essence of the general education lies in the basic needs and wants of men, then mathematics has a larger potential contribution than figuring taxes, keeping a budget, understanding the national debt, or appreciating the measure of light waves, as important as they are. (p. 159)

The Basic Mathematics Program in use in Newfoundland secondary schools, particularly in grade ten, emphasizes 'social' material. Much has been expressed concerning such material in mathematics programs. Ferguson (1970) felt that social applications of mathematics might be added to the college-preparatory sequences. There could be a semester or a year course for seniors in what might be called 'consumer mathematics'. Wilson (1960) questioned why, despite whatever thought has gone into the organization of such consumer courses, we still were so far from our goal in mathematics for this type of student. He suggested that there may be four main reasons:

1. Courses in consumer mathematics do include many socially useful topics, but these topics do not involve enough real mathematics.

2. There is no reason to believe that high school students find these social units either interesting or important.

3. High school teachers, burdened by responsibilities, cannot spend a lot of time searching for new socialized material.

4. We are living in a period of such rapid change that we cannot possibly plan an education program on the basis of social utility. (pp. 521 - 522)

Wilson concluded that we have no choice but to turn to mathematics itself for the source of our teaching, regardless of the nature of the student body. He pointed out that the teaching of concepts is central to all mathematics courses and that "mathematics for the college-preparatory student and mathematics for the terminal student will differ only in degree". (p. 522).

In the Arithmetic Teacher, (National Council of Supervisors of Mathematics, October 1977) there was presented a position paper on basic mathematics skills. They proposed ten basic skill areas; (1) problem solving; (2) applying mathematics to everyday situations; (3) alertness to reasonableness of results; (4) estimation and approximation; (5) appropriate computational skills; (6) geometry; (7) measurements; (8) reading, interpreting, and constructing tables, charts, and graphs; (9) using mathematics to predict; and (10) computer literacy, This proposal drew attention to skills which would have to be considered in the development of any mathematics program.

Thus, we find that there are ardent advocates of the general student learning 'pure' mathematics and not being subjected to studying content which basically applied pre-high school mathematics to consumer oriented material and advanced very little in pure mathematics. Of course, there are opponents of this view. Zant (1949) gave his views on the mathematics that was needed by the ordinary citizen. In summary his suggestions were as follows:

1. The content through the eighth grade: emphasis should be on the meanings and understandings, but close attention must be paid to skills and knowledge.

2. Functional competence: this included the fundamental operations with whole numbers, per cent, fractions, decimals, ratio, tables, statistics, geometry ideas, measuring, formulas, signed numbers, similar triangles, and mathematics of the home and business.

Zant felt that if students forgot these things, then it was the responsiblity of the secondary school to reteach them in the hope that the constant exposure would eventually result in the development of the desired skills. He stressed the basic skills-oriented program. Sobel (1967) disagreed with this view by stating that

> Not only does this routine fail to produce skills, it also succeeds in killing any interest these youngsters may have had for mathematics. For the low-achiever such a program proves to be dull, deadly and destructive of all interest - with emerging

discipline problems. (p. 7)

Sobel (1959) also had pointed out that even courses that have a heavy emphasis on concept building are firm in their insistence that the basic skills must accompany the ideas.

Sobel did not imply a lessening of the importance of skill development, but he indicated that the art of teaching included working with students toward the mastery of these skills in ways that make the task acceptable to both the teacher and the students. Colerus (1968) also felt that the general student should know more than the fundamental skills and consumer mathematics. He exemplified this view by commenting:

> It is an extremely unsatisfactory state of affairs, almost amounting to scandal, that a reader should be frightened and put off by a row of hieroglyphics in the middle of a serious treatise or that he should have to let a small number of the initiated finish their readings whilst he can only stand by and shrug his shoulders. I am not talking about anything on such a high level as theory of relativity or the quantum theory but of mathematics which might appear in any medical or economic journal... Besides, mathematics crops up much more slyly in everyday speech. (pp. ix - x)

Bell (1974) claimed that all students need a sound mathematics base that goes beyond mere computational skills. They need such a base in order to understand the many important decisions they would have to make in their personal and public lives. Every student, he suggested, must be provided with a base such that additional learning of mathematics can go from there. He provided a list of what he considered to be minimum residue for every person from the school mathematics experience. (See Appendix B). This list included topics such as; the main use of numbers; use of computational algorithms; relations such as equal, similiar, congruent, and subsets; use of variables, fundamental probability and descriptive statistics; geometric relations; and interpretation of informational graphs. Dodes (1967), in giving his views of the liberal-arts approach to mathematics, gave what appeared to him to be among the 'big' ideas which seem important. (See Appendix C) Included among these topics are (1) mathematicians, (2) the basic nature and laws of numbers, (3) interpretations of graphs, (4) making and solving equations, (5) indirect measurement, (6) logic, and (7) experimental geometry and techniques.

Weiss (1969) carried out a study whereby he gathered the opinions of 172 leading mathematics educators on what mathematics should be taught to low-achievers in junior high school. He sent each person a list of forty-seven possible topics and the respondents were asked to indicate on a five-point scale their opinion on the inclusion of each of the topics in the program. A rating of 1 for any topic meant that it should not be included; a rating of 5 meant that it should be included. Ratings of 2 and 4 showed a leaning toward non-inclusion and inclusion, respectively, while a rating of 3 showed doubt. The topics and the nature of the recommendations for each topic are shown in Appendix D. Generally, the study tended to confirm that there are conflicting views on what mathematics is most suitable for low-achievers. There was an especially deep division of opinion as to whether topics often associated with 'social' mathematics should be taught to low-achievers.

Wilson (1960) listed a few topics which he felt appeared to qualify as good vehicles for developing understandings of mathematical concepts, and at the same time, hold the attention of the students who probably will not continue the study of mathematics beyond high school. These topics are listed, along with some comments in Appendix E. Wilson emphasized the teaching of pure mathematics with concepts forming the core; however, he strongly suggested that when each topic is taught, some relationship with ordinary life activities must always be shown. These applications are not to be the main aspects of the course. They are only peripheral and motivational.

Edwards (et al 1972) suggested a list of minimum 'doing' skills that every 'enlightened' citizen should possess. These skills (see Appendix F) are in the areas of (1) numbers and numerals, (2) operations and properties, (3) mathematical sentences, (4) geometry, (5) measurement, (6) relations and functions, (7) probability and statistics, (8) graphing, (9) mathematical reasoning, and (10) business and consumer mathematics. If the general student is to be an enlightened citizen then advocates of Edwards' views would include the above topics in a mathematics program for them.

Programs have been devised which attempt to incorporate such skills in a reasonable balance. One such program was used in high schools in Baltimore, Maryland (see Appendix G). Gerardi (1965), in discussing this particular program for below-average pupils stated:

> We believe that the mathematics courses should be related to probable needs of the lives of the students. Subject matter should be presented so as to stress key ideas and basic skills in order that post-high school study will be possible. The program should be designed to prepare a pupil to handle effectively the mathematical problems and experiences he will probably meet in later life. (p. 27)

In Baltimore County in the 1960's a "banded" approach was used in teaching mathematics in grades 7 to 11 (National Council of Teachers of Mathematics, 1972). This approach was based on the assumption that slow learners have a limited span of attention. A lesson normally had three bands. Band I, averaging 5 - 10 minutes, provided activities which attempted to maintain skills and to arouse curiosities; Band II, lasting about 25 minutes, dealt with the major topics of the day; and Band III, averaging 5 - 10 minutes, provided activities such as puzzles, games, tapes, and skill kits. The intent was to keep the students involved in learning activities from the beginning to the end of the class.

In New York City in 1968, a computer-assisted instruction (CAI) program had begun (National Council of Teachers of Mathematics, 1972). This program was devised for the slow learners. The CAI assisted the teacher by providing daily individualized instruction to large numbers of students. This applied modern technology to the classroom. The computer used the information given to it by a curriculum author to drill 192 students simultaneously. Each student was given lessons geared to his won learning ability. He was asked questions hard enough to make him work but not too hard for him to answer.

In Highland, New York, the high school offerred a statistics course for the non-college-bound student (Gallagher, 1979). This course included such topics as correlation, variability, probability, analysis of variance, and linear regression analysis. She felt that the key to success was that the pace was very slow with a constant check from student feedback.

In Santa Fee at Des Moines High School, experiments with programmed mathematics were carried out. (Morrow, 1965). It was felt, though, that by using such material too many students were missing too much of the teacher-pupil relationship and closeness. Such mathematics would best be used as supplementary to the regular classroom situation.

Around 1967, the Sir. R. L. Bordon Secondary School was built in Scarborough, Ontario, to accomodate low achievers. (National Council of Teachers of Mathematics, 1972). Here the mathematics laboratory was utilized whereby the students were in shop-work for half the day and in academic classes for the other half. The activities in mathematics would involve drill, the use of calculators, skill-builder film-strips, overhead transparencies, computational skill-building kits, tape recordings, and programmed learning materials. Each topic would last for 4 - 5 weeks. The teacher chose the program suitable to the needs and abilities of his class. The mathematics topics ranged from geometry, algebra of sets, and arithmetic to budgeting, mathematics in shops and the home, insurance and taxations.

In the early 1960's, a mathematics program for low achievers was developed for the public schools of Fort Worth, Texas (The Low Achiever in Mathematics). The program was based on the assumption that low achievers can learn good and strong mathematics, but slowly. It spread the equivalant of first year algebra over a two year period and included elements of geometry, trigonometry and statistics. The program was designed to be flexible enough to allow a student to leave the program after grade 10 and go onto a college-preparatory program in grade 11.

In the summer of 1966, Maryland teachers were invited by the State Supervisors of Mathematics to provide some sources of ideas and information for teachers of general mathematics (Handbook for General Mathematics, 1966). The result was a handbook which was not designed as a textbook nor a course guide but merely a source of ideas and approaches to mathematics for all teachers of general mathematics. The materials were in the content areas of natural numbers, integers, rational numbers, and geometry. It provided games, activities and miscellaneous material dealing with such items as probability, paper folding, finger computation, and magic squares.

The above indicates some idea of the efforts made to improve mathematics for the slower students. However, there was not complete satisfaction with the results of these efforts. The question of whether students could perform practical arithmetic computation came into focus. The NACOME Report (1975) stated:

> Development projects responding to this call have focused mainly on pedagogical innovations to meet the special need of slow-learners - variety of activity, physical embodiment of ideas, low reliance on reading, more practice arithmetic skills, motivation by practical utility of skills, etc. As a result, logical structure has often taken a back seat to pedagogical possibilities in determining curriculum content. (p. 32)

Hestwood (1973, p. 696) implied that instructional materials written by people actually teaching the students should be more appropriate than those written by someone writing for a 'theoretical' student body; furthermore, there should be a balance between drill and explanation. Ogle (1970) felt that the content of programs for low-achievers should include interesting review of old topics, new material, and engaging drill. He said that "the emphasis should be placed on students participation through a variety of learning experiences" (p. 305) including work in the mathematics laboratory, games, and discovery activities.

The 1960's did show a focusing of attention on the mathematics programs for the general students. It was recognized that too little attention had been given to these students in the past. However, educators were not in complete agreement as to the type of mathematics these students should study in high school.

Summary

Relatively little work had been done on programs for the non-university-bound student prior to 1960. In fact, as a result of a study of the mathematics objectives in the United States from 1920 to 1960, Boliver (1971) reported that the only major change to be found was the creation of the general mathematics course at the ninth grade level. Not until the 1960's did any really significant work and recommendations come to the front.

Material written since 1960 indicated two major schools of thought concerning the types of programs for these students. One supports a utilitarian view of mathematics where the major objectives should be (1) to produce students who are enlightened in the everyday consumer world, and (2) to produce students who are proficient in arithmetic calculations so as to be able to move on to specific job or skill training. The other proposes the study of mathematics for its own sake. This view supports the belief that, since it is difficult to determine exactly what mathematics will be necessary for jobs in future years and to determine what mathematics individual students will need in later life, then it is the obligation and responsibility of the schools to teach these general students from the discipline of pure mathematics. The opinions in the literature reviewed by the researcher seemed to support this latter view of the type of program for the general student. A dominant inference drawn from the literature was that students, taught from pure mathematics, should be able to adequately handle the mathematics required for specific role training when the need arises.

Obvious from this review of literature is the need for additional studies. This was pointed out by Dessert (1964) when he said

> Such studies, which are likely to provide valid conclusions upon which to base curricular decisions, must become standard rather than unusual if future research in mathematics education is to make exceptional contributions to the improvement of instruction. (p. 298)

CHAPTER III

DESIGN OF THE STUDY

This study was designed to answer questions pertaining to the perceptions of mathematics teachers from Newfoundland high schools and trades school relative to their opinion concerning the inclusion of given content items into a non-university preparatory program for grades 9, 10, and 11.

In order to answer these questions, 90 examples of content items for such a general program were identified. They were categorized in eleven different areas of mathematics. In order to encourage the greatest possible number of replies from high school teachers, these items were randomly placed into two groups of 45 items each. Each group of items formed one questionnaire. These two questionnaires were used to obtain the information from the two groups of teachers.

In this chapter descriptions of the formulation of the list of content items, the selection of the samples for the study, and the administration of the instruments are presented.

Choosing the content items

The list of possible content items used in this study was devised as a result of a review of literature pertaining to the 'general' or non-university-capable student. Special reference was made to the writings found in journals published by the National Council of Teachers of Mathematics (NCTM). In particular, note was made of writings of Bell (1974), Colerus (1968), Edwards et al (1972), and Weiss (1969). The content items used in this study were not direct reprints from any one source but rather they were a synthesis of those from different sources, including some based on the experiences of the writer.

The list of content items was intended to be fairly comprehensive although the nature of the study, by necessity, limited its extent. An attempt was made to avoid ambiguity and to clearly state the intent of each of the content items. Although this study dealt with a general mathematics program for grades 9, 10, and 11 no attempt was made by the writer to suggest to the respondents the grade level at which any content item should be introduced or whether the development of any content item should take place over a one, two, or three year period.

There were a total of 90 items in the list. (See Appendix P) This was not an exhaustive list but merely a sample of items. An initial list of fewer than 90 content items was subjected to careful study by the writer, his program advisors, and a small group of colleagues. This was done to eliminate any repetitions and ambiguities and to find any possible and practical extensions to the list. A sample questionnaire was studied by a pilot group of teachers who were asked to assess the questionnaire with the aim of improving it. From this a revised questionnaire containing 90 items was produced for administration. These items were placed in eleven categories; A - performing operations on number system; B - recognizing properties of given number systems; C - arithmetic computation; D - number theory; E - algebra; F - geometry; G - trigonometry; H - measurement; I - statistics; J - business and consumer mathematics; and K - logic.

The items were placed in these categories and then numbered, in order, from 1 to 90. In Chapter IV, individual items are frequently referred to by letter and number. The letter identifies the category, as described above, in which the item is found and the number distinquishes it from the other 89 items. No two items were assigned the same number. For example, Item E33 refers to the thirty-third item in the list of items and it is found in Category E (algebra).

The instruments

The respondents were asked to consider the given possible content items after first having ranked from 1 to 3, in perceived order of importance, three aims for a general mathematics program being studied by the researcher. This was done in an attempt to identify what these teachers perceived as aims for such a program. These aims were:

(a) Everyday living: to provide a program which emphasizes the practical, social, and computational aspects or skills which are necessary for everyday living.

(b) Vocational: to provide a program which will provide the student with mathematics concepts enabling them to enter the workforce or to begin studies at a vocational or trades school in courses which the Provincial Division of Vocational Education has described as requiring one full year of study.

(c) Remedial: to provide a program which will offer remedial work to students who have experienced difficulties with mathematics and will offer them the opportunity to return to an academic mathematics program (i.e. the present Matriculation program or its equivalent).

The 90 content items were placed randomly by means of random tables into two forms, each of which contained 45 items. No attempt to categorize the items was made on these forms. (See Appendix N and O). Opposite each item was a scale from 1 to 5 and the respondents were asked to rate each of the items using this scale which was defined as follows:

1 - definitely should be included in the program
2.- probably should be included in the program
3 - undecided
4 - probably should not be included in the program
5 - definitely should not be included in the program.

An effort was made to ensure that the respondents would recommend an item for inclusion in a general program from the viewpoint that it would be considered as a core topic and not in the program merely for the purpose of exposing the students to the topic. This was attempted by means of a letter forwarded to each respondent. (See Appendices J and K). A follow-up letter was forwarded to schools from which replies seemed slow in coming. (See Appendix L).

Each form contained two questions. The first question asked each respondent to state any aim other than those stated which he felt such a program should meet. The other invited each respondent to state his general views concerning the need for such a general mathematics program as described in this study.

The teachers were also asked to complete a sheet whereby they would give information on their teaching experience, educational background, and age. (See Appendix M).

Population and sample

The present study involved mathematics instructors who were teaching in various high schools and trades schools throughout the province of Newfoundland. These groups are referred to as HST and TST, respectively, throughout the remainder of this study. The trade school teachers were those teaching mathematics to students of various trades.

This group did not include those teaching only the students on the high school upgrading program. As this study was concerned with selecting content items for a general mathematics program, the population of trades school teachers was restricted to those from district vocational schools and eliminated those from the Mathematics and Computer Science Department of Memorial University of Newfoundland, as well as those at the College of Trades and Technology and the College of Fisheries. Some were restricted from the population because their experience involved students from an academic mathematics program, at least in the great majority of cases. Therefore, they were eliminated on the assumption that they might be biased toward the academic programs. In any event, it is an assumption of the study that the great majority of high school students from the Basic program who move on to post-secondary institutions attend district vocational schools.

From discussions with a principal of such a district vocational school, the researcher discovered that most such schools have only one teacher of mathematics for the trades students. However, some of the larger schools may have two such instructors. A total of 16 district vocational schools were contacted. Replies were received from 14 schools and 17 instructors.

The population of high school teachers consisted of those teaching mathematics in the high school grades in the province of Newfoundland. The names and addresses of all school boards in the province were obtained from one school board office. The names and addresses of schools containing high school grades were obtained from these school boards. Schools from different geographical areas of the province were contacted by mail. This involved 25 schools, including some of the larger city high schools and some of the smaller rural high schools, from the eastern, western, central, and northern sections of Newfoundland. The exact numbers of mathematics teachers on the staff of these schools were not known; neither was the exact number of teachers contacted known. Questionnaires were forwarded to the schools. Replies were received from 23 of the 25 schools and from a total of 64 respondents.

The administration of the instruments

The questionnaire was ready to be forwarded to the teachers on May 5, 1978. Due to the lateness in the school term, the most efficient and quickest way of contacting respondents was to mail the questionnaires to the principals or mathematics department heads of the schools involved.

In order to encourage the greatest possible number of returns from the high school teachers so late in the school year, the original questionnaire which contained 90 content items grouped in eleven categories was placed on two forms each of which contained 45 items randomly selected from the original 90. There was no categorization of these items on these two forms, and there were no repetitions within any one form nor between the two forms. The forms were mailed to the high school principals or mathematics heads on May 5, 1978, and they distributed them to their mathematics teachers.

Since the population, and therefore the sample, which was nearly the size of the population, of trades school teachers was relatively small, each respondent was asked to complete both forms for the total of 90 content items. These were also mailed to the district vocational schools on May 5, 1978.

The task of each respondent was, first of all, to rank the three stated aims in perceived order of importance from 1 to 3. (See Appendix M) Based on these rankings, each respondent was asked to rate each content item on a scale of 1 to 5 by circling a number on this scale situated to the right of each item. (See Appendix N) The scale was described earlier in this chapter.

Most of the questionnaires were returned within two weeks. After two weeks a follow-up letter was sent to the high schools and the trades schools which had not sent replies by that time. (See Appendix L) This letter requested that the principals and/or mathematics department heads encourage their mathematics teachers to complete and return their forms. Each school was provided a stamped, self-addressed envelop. This follow-up letter resulted in some additional replies. Replies came from approximately 87% of the trades schools contacted and 92% of the high schools contacted.

Analysis

Analysis of the frequencies of each rating for each of the 90 content items was carried out for the samples of high school and trades school teachers. These items were regrouped and placed in their respective categories as mentioned earlier. For each item, an index was identified for each group of respondents in the following manner. The rating of each item was multiplied by the frequency of that rating. These partial products were added and then divided by the total number of respondents for that item.

The teachers from both samples were grouped according to their rankings of the aims for the program. Analysis was carried out on each group. The comparison of these groups is presented in Chapter IV.

For each content item for each group and each subgroup a recommendation to include the item in the non-university preparatory mathematics program was made if the assigned index was less than 2.5 and the number of respondents indicating that the item should be included (i.e. giving a rating of 1 or 2) in the program was at least twice as many as the number indicating that the item should not be included (i.e. giving a rating of 4 or 5). A recommendation to exclude the item from the program was made if the assigned index was greater than 3.5 and the number of respondents indicating that the item should be excluded was at least twice as many as those indicating that it should be included. If the assigned index was greater than or equal to 2.5 but less than or equal to 3.5 there was no decision made relative to a recommendation for inclusion.

An attempt was made to observe any relationship between the ranking that high school teachers gave the aims and their university training, their ages, their general teaching experiences, experience with non-academic mathematics, and their teaching-grade certificate. This was done by observing the latter variables and the orderings they gave the three aims.

CHAPTER IV

ANALYSIS OF THE DATA

In this chapter an analysis of the data collected through the use of the instruments described in Chapter III is presented. The analysis of the data was performed in order to answer the questions proposed in Chapter I.

The responses

The data were collected by mail. The respondents were asked to forward their replies within two weeks after receiving the questionnaires. Most of the replies came within that time period. A follow-up letter was sent to the schools in order to encourage replies from teachers who had not responded within that two week period. This resulted in additional replies. It was impossible to determine the percentage of returns from individual respondents as the questionnaires were forwarded to the principals and mathematics department heads in the schools involved. They, in turn, distributed them to their mathematics teachers. However, 92% of the high schools contacted sent replies for a total of 64 respondents, while 87% of the trades schools replied for a total of 17 respondents.

Treatment of the responses for the groups HST and TST

The responses were tabulated on frequency sheets.

This provided the frequency of each of the five ratings for each item for the groups HST and TST. In Table 1 and Table 2 are presented the indices for each item as given by all the high school teachers (HST) and all the trades school teachers (TST), respectively. Each index was calculated by multiplying each rating for a given item by the frequency for that item and then dividing the sum of these products by the total number of respondents rating that item. Included in these tables are the recommendations for these two groups of teachers relative to the question of these items being included in the general mathematics program for grades 9, 10, and 11. A recommendation to include an item was made when the index was less than 2.5 and the number of respondents favoring inclusion (i.e. rating it 1 or 2) was at least twice as many as the number favoring exclusion (i.e. rating it 4 or 5). If the index was greater than 3.5 with the number of respondents favoring exclusion at least twice as many as the number favoring inclusion, a recommendation for exclusion was made. Otherwise, no recommendation was made. No consideration of the ranking of the three aims for the program by these teachers was made in producing these two tables. As described earlier, the coding used to identify each item is such that the letter refers to the category of items to which it belongs and the number distinquishes it from the other 89 items listed.

Table 1

Item Index and Recommendation for HST.

Content Items	Index	Recommendation	Content Items	Index	Recommendation
A1	1.16	Include	F46	1.94	Include
A2	1.28	Include	F47	2.66	Undecided
A3	1.34	Include	F48	2.59	Undecided
A4	3.16	Undecided	F49	2.75	Undecided
B5	2.66	Undecided	F50	3.25	Undecided
B6	2.97	Undecided	F51	2.25	Include
B7	2.91	Undecided	F52	1.56	Include
B8	3.47	Undecided	F53	1.91	Include
C9	1.72	Include	F54	1.34	Include
C10	1.22	Include	G55	2.61	Undecided
C11	3.00	Undecided	G56	2.22	Include
C12	1.31	Include	G57	2.44	Include
C13	1.25	Include	G58	2.62	Undecided
D14	3.16	Undecided	G59	3.72	Exclude
D15	3.29	Undecided	H60	1.44	Include
D16	1.78	Include	H61	1.41	Include
D17	1.69	Include	H62	1.78	Include
D18	1.66	Include	H63	2.09	Include
D19	3.16	Undecided	H64	2.97	Undecided
D20	2.41	Include	H65	2.97	Undecided
E21	2.50	Undecided	H66	2.25	Include
E22	2.69	Undecided	H67	2.56	Undecided
E23	2.72	Undecided	I68	3.41	Undecided
E24	2.69	Undecided	I69	3.09	Undecided
E25	3.06	Undecided	I70	3.63	Exclude
E26	3.38	Undecided	I71	3.50	Undecided
E27	3.00	Undecided	I72	3.75	Exclude
E28	3.53	Exclude	I73	3.34	Undecided
E29	3.16	Undecided	J74	1.62	Include
E30	3.47	Undecided	J75	1.41	Include
E31	2.22	Include	J76	1.31	Include
E32	2.32	Include	J77	1.47	Include
E33	3.16	Undecided	J78	1.47	Include
E34	2.91	Undecided	J79	1.56	Include
E35	3.16	Undecided	J80	1.34	Include
E36	3.94	Exclude	J81	1.37	Include
E37	2.19	Include	J82	1.25	Include
E38	3.88	Exclude	J83	1.44	Include
E39	3.81	Exclude	K84	2.75	Undecided
E40	3.25	Undecided	K85	2.22	Include
E41	3.78	Exclude	K86	3.16	Undecided
E42	1.47	Include	K87	2.94	Undecided
E43	2.13	Include	K88	2.16	Include
E44	2.06	Include	K89	2.31	Include
E45	1.53	Include	K90	3.84	Exclude

Table 2

Item Index and Recommendation **for TST.**

Content Items	Index	Recommendation	Content Items	Index	Recommendation
A1	1.41	Include	F46	1.18	Include
A2	1.24	Include	F47	2.06	Include
A3	1.18	Include	F48	1.47	Include
A4	2.77	Undecided	F49	1.18	Include
B5	2.97	Undecided	F50	2.59	Undecided
B6	2.82	Undecided	F51	1.38	Include
B7	2.88	Undecided	F52	1.18	Include
B8	3.29	Undecided	F53	1.18	Include
C9	1.00	Include	F54	1.06	Include
C10	1.12	Include	G55	1.47	Include
C11	1.56	Include	G56	1.29	Include
C12	1.17	Include	G57	1.53	Include
C13	1.12	Include	G58	1.59	Include
D14	4.00	Exclude	G59	2.18	Include
D15	3.82	Exclude	H60	1.00	Include
D16	1.23	Include	H61	1.06	Include
D17	1.29	Include	H62	1.24	Include
D18	2.00	Include	H63	1.60	Include
D19	3.82	Exclude	H64	2.24	Include
D20	1.88	Include	H65	1.88	Include
E21	1.65	Include	H66	1.38	Include
E22	1.53	Include	H67	2.76	Undecided
E23	1.71	Include	I68	4.12	Exclude
E24	2.12	Include	I69	3.88	Exclude
E25	2.35	Include	I70	3.94	Exclude
E26	2.82	Undecided	I71	3.76	Exclude
E27	2.59	Undecided	I72	3.71	Exclude
E28	2.53	Undecided	I73	3.88	Exclude
E29	2.76	Undecided	J74	2.18	Include
E30	2.53	Undecided	J75	2.12	Include
E31	1.47	Include	J76	2.29	Include
E32	1.65	Include	J77	2.26	Include
E33	3.18	Undecided	J78	2.12	Include
E34	2.00	Include	J79	2.35	Include
E35	2.24	Include	J80	2.12	Include
E36	2.88	Undecided	J81	2.06	Include
E37	1.82	Include	J82	1.94	Include
E38	3.12	Undecided	J83	1.76	Include
E39	3.53	Exclude	K84	2.29	Include
E40	2.35	Include	K85	1.76	Include
E41	3.35	Undecided	K86	3.24	Undecided
E42	1.41	Include	K87	2.82	Undecided
E43	1.29	Include	K88	1.71	Include
E44	1.29	Include	K89	2.59	Undecided
F45	1.18	Include	K90	3.06	Undecided

Evident from these tables was that there was some agreement and some disagreement between the views of these two groups of teachers. In order to gain greater insight into the distinctive features of the agreement and the disagreement, other tables were produced. In Table 3 are presented the content items from the original list of 90 items which both the high school and the trades school teachers recommended for inclusion in such a mathematics program having the aims as stated.

Upon inspection of Tables 1, 2, and 3 it was observed from the indices that these two groups of teachers agreed on including a number of items where, for each of these items, the indices assigned by them differred by less than 0.50. These items were:

1. Items A1, A2, and A3 (dealing with performing operations on number systems).
2. Item C10 (computing with percent).
3. Item C12 (rounding off numbers).
4. Item C13 (converting from one mode of numeral to another).
5. Item D17 (finding the LCM).
6. Item D18 (writing prime factorization).
7. Item E37 (solving word problems using linear equations with one variable).
8. Item F42 (studying basic geometric concepts).
9. Item F45 (performing basic constructions).

10. Item F52 (defining and identifying different types of triangles).

11. Item F54 (applying formulas for area and perimeter).

12. Item H60 (linear measure).

13. Item H61 (square measure).

14. Item H63 (angular measure).

15. Item J83 (using mechanical aids to calculation).

16. Item K85 (putting together a logical argument).

17. Item K88 (using deductive reasoning).

Some of the areas of agreement in the views of these two groups of teachers were noted in that neither group considered any items from Category I (Statistics) as suitable for this mathematics program. In fact, the TST group tended to exclude all statistical related items. Both groups were undecided about Category B (Recognizing Properties). They did agree to include all items in Category J (Business and Consumer Mathematics).

As stated earlier, the index 1 indicated the opinion that an item "definitely" should be included in the program while the index 2 indicated that an item "probably" should be included. It was observed from Tables 1, 2, and 3 that in about 70% of the cases where both the high school teachers and the trades school teachers agreed in their recommendation for inclusion, the trades school teachers' indices were nearer the index 1 than were those

Table 3

Items Included by HST and TST.

Item	Description
A1	Performing operations on whole numbers.
A2	Performing operations on integers.
A3	Performing operations on rational numbers.
C9	Computation involving ratio and proportions.
C10	Computing with percent.
C12	Rounding off numbers.
C13	Converting from one mode of numeral to another.
D16	Finding the greatest common factor of two whole numbers.
D17	Finding the least common multiple of two whole numbers.
D18	Writing prime factorization of natural numbers.
D20	Writing numerals in scientific notation.
E31	Solving linear equations of the type $ax + b = c$, where $a, b, c \in I$.
E32	Solving linear equations of the type $ax + b = cx + d$, where $a, b, c, d \in I$.
E37	Solving word problems using linear equations with one variable.
F42	Studying some basic concepts of geometry (eg. line, point)
F43	Defining and applying types of lines (eg. parallel, perpendicular, intersecting).
F44	Naming and identifying properties of simple plane figures (eg. the triangle).
F45	Performing basic constructions with ruler, pencil, and compass.
F46	Stating and applying the Pythagorean Theorem.
F51	Defining and identifying different types of triangles.
F52	Defining and identifying different types of angles.
F53	Defining and identifying parts of the circle.
F54	Applying formulas for finding area and perimeter of common plane figures (eg. the triangles).
G56	Knowing the relationships among the basic trigonometric ratios as related to the right triangle.
G57	Solving right triangles using the basic trigonometric ratios.
H60	Finding and computing with linear measure.
H61	Finding square measure as in area of common plane figure and solids.
H62	Finding cubic measure as in volume of a rectangular solid.

Table 3 (continued)

Item	Description
H63	Finding and computing with angular measure.
H66	Finding measures indirecly by using similar triangles and proportions.
J74	Preparing and working on budgets.
J75	Solving problems dealing with installment buying.
J76	Solving problems dealing with buying a car.
J77	Solving problems dealing with buying a home.
J78	Solving problems dealing with borrowing money.
J79	Solving problems dealing with insurance (car, life, fire, home).
J80	Solving problems dealing with personal bank records.
J81	Solving problems dealing with sales and income taxes.
J82	Solving problems dealing with personal earnings.
J83	Making intelligent use of mechanical aids to calculation.
K85	Putting together a logical argument.
K88	Using deductive reasoning.

of the high school teachers. The opposite was true for the items relating to Business and Consumer Mathematics where the high school teachers seemed more "definite" about the inclusion of such items. This was also true for the item dealing with the writing of prime factorization.

Table 4 shows the items for which the calculated indices indicated that the TST group recommended their inclusion in the program while the HST group were undecided about it. As observed from Tables 1 and 2, for all but one of these items (i.e. Item K84), there was a difference of greater than 0.50 in the indices assigned by these high school and trades school teachers. The TST group recommended the inclusion of eight algebra items more than the HST group who favored the inclusion of only three items from this category. Category E contains the algebra items.

The only item from the original list of 90 items which the HST group recommended for inclusion in the program while the TST group was undecided about it was Item K89 (determining the validity of an argument) from Category K. However, the difference between the assigned indices for these two groups of teachers for this item was only 0.29.

In Table 5 are presented the content items about which no decision for either group on the question of inclusion in the proposed mathematics program could be made from the indices as shown in Table 1 and 2. The feature of note here was that in about 80% of the cases there was less than a 0.50 difference between the indices of the two groups of teachers. Both groups were uncertain in their recommendations of including or excluding all items in Category B (Recognizing Properties). Five algebra items were in this same state of uncertainty. This gave a total of sixteen algebra items from the 21 in Category E (Algebra) for which neither group recommended exclusion.

In Table 6 are presented the content items which had indices assigned by both groups of teachers recommending that they be excluded from the proposed general mathematics program. The two groups seemed to agree strongly

Table 4

Items Included by TST, Undecided by HST

Item	Description
C11	Solving problems using direct variation.
E21	Knowing the language of algebra (eg. variable, polynomial, equation).
E22	Adding and subtracting non-fractional algebraic expressions (i.e. combining like terms).
E23	Knowing and applying laws of exponents ($a^m \cdot a^n = a^{m+n}$; $a^m \div a^n = a^{m-n}$; $(a^m)^n = a^{mn}$).
E24	Adding and subtracting polynomials in one variable.
E25	Multiplying polynomials (monomials, binomials, trinomials) in one variable.
E34	Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, using tables of values.
E35	Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, using the slope-intercept method.
E40	Solving systems of linear equations in two variables by the substitution and/or addition methods.
F47	Identifying congruent triangles by the SSS, ASA, and SAS conditions.
F48	Applying properties of similar triangles to solve problems.
F49	Applying the Distance Formula.
G55	Defining basic trigonometric ratios, using the right triangle.
G58	Solving applied problems using the basic trigonometric ratios relative to the right triangle.
H64	Finding units of precision and greatest possible error with measurements.
H65	Finding the relative error and the percent of error in measurement.
K84	Making a flow-chart organization for problem solving.

on these items in that the greatest absolute difference between the indices for any item was 0.31. Two of these three items belonged to the Category of Statistics.

Table 5

Items Undecided by TST and HST.

Item	Description
A4	Performing operations (addition, subtraction, multiplication, division) on irrational numbers.
B5	Recognizing properties (commutative, associative, distributive, inverses, identities) of whole numbers.
B6	Recognizing properties (commutative, associative, distributive, inverses, identities) of integers.
B7	Recognizing properties (commutative, associative, distributive, inverses, identities) of rational numbers.
B8	Recognizing properties (commutative, associative, distributive, inverses, identities) of irrational numbers.
E26	Dividing polynomials having one variable.
E27	Finding common factors for polynomials.
E29	Factoring polynomials of the type $x^2 + bx + c$, where $b, c \in I$.
E30	Factoring polynomials of the type $ax^2 + bx + c$, where $a, b, c \in I$.
E33	Solving linear inequalities of the type $ax + b > c$, where $a, b, c \in I$.
F50	Finding the coordinates of the midpoint of a segment.
H67	Using instruments to make readings for indirect measurement (eg. the transit).
K86	Disproving a statement by counterexample.
K87	Proving a simple theorem.

The content items recommended for exclusion from the proposed program by the TST group, but about which the HST group was undecided, are presented in Table 7. As observed from Tables 6 and 7 the TST group recommended excluding items from three categories only, namely, Category D (Number Theory), Category E (Algebra), and Category I (Statistics). They tended to exclude all items from Stat-

Table 6

Items Excluded by HST and TST

Item	Description
E39	Graphing inequalities of the type $ax > by + c$, where $a, b, c \in I$.
I70	Finding measures of central tendency (mean, mode, median, skewness).
I72	Calculating measures of dispersion (range, variance, standard deviation).

Table 7

Items Excluded by TST, Undecided by HST

Item	Description
D14	Naming the union and intersection of given sets.
D15	Defining and naming subsets of given sets.
D19	Finding the absolute value of rational numbers.
I68	Distinquishing between descriptive and inferential, statistics.
I69	Writing frequency distributions and graphing them.
I71	Calculating percentiles in statistical data.
I73	Probability (concept of randomness, approaches to probability).

istics but only one from Algebra.

The items recommended for exclusion from the program by the HST group, but about which the TST group was undecided are presented in Table 8. With the exception of item I71 there was a difference of greater than 0.50 for

Table 8

Items Excluded by HST, Undecided by TST.

Category	Description
E28	Factoring polynomials of the type $a^2 x^2 - c^2$, where $a, c \in I$.
E36	Solving quadratic equations of the type $ax^2 + bx + c = 0$, by the Quadratic Formula.
E38	Graphing quadratic equations of the type $y = ax^2 + bx + c$, where $a, b, c \in I$.
E41	Recognizing a function from given sets of ordered pairs of points.
K90	Studying the history of mathematics.

the indices assigned by these two groups. The high school teachers favored the exclusion of items from two categories - Category E (Algebra) and Category I (Statistics). These included five Algebra items but only two Statistics items.

The assigned indices indicated no content item which was recommended by the HST group for inclusion in the proposed program while being recommended for exclusion by the TST group. One item (Item G59) - defining basic trigonometric ratios using the unit circle - was rejected by the HST group while it was recommended for inclusion by the TST group.

In Table 9 are presented the average ratings given each of the eleven categories of content items by both the high school and the trades school teachers and the state of recommendation accompanying each category. The main feature

Table 9

Average Category Index and Recommendation by HST and TST

Category of Items	Average rating by HST	Average rating by TST	Recommendation by HST	Recommendation by TST
A-Performing Operations	1.74	1.65	Include	Include
B-Recognizing Properties	3.00	2.98	Undecided	Undecided
C-Arithmetic Computation	1.78	1.19	Include	Include
D-Number Theory	2.45	2.58	Include	Undecided
E-Algebra	3.09	2.39	Undecided	Include
F-Geometry	2.11	1.50	Include	Include
G-Trigonometry	2.72	1.61	Undecided	Include
H-Measurement	2.18	1.66	Include	Include
I-Statistics	3.45	3.88	Undecided	Exclude
J-Business and Consumer Mathematics	1.42	2.12	Include	Include
K-Logic	2.77	3.54	Undecided	Exclude

of note here was the fact that, on the average, the trades school teachers and the high school teachers seemed to agree on Categories A, B, C, F, H, and J. The degree of agreement was especially strong for Category A (Performing Operations) and Category B (Recognizing Properties) where the difference between the indices was 0.09 and 0.02, re-spectively. However, there was some disagreement between the two groups on Category D (Number Theory), Category E (Algebra), Category G (Trigonometry), Category I (Statis-tics), and Category K (Logic) where one group did not seem to be able to decide on the question of inclusion while the other had made some decision, as indicated in Table 9. The difference for Category D, though, was rather small: 0.13.

The TST group, in general, favored excluding the categories of Statistics and Logic; they were undecided on the question of including categories B and D. The HST group, however, did not exclude any whole category of items from the program but was undecided in five cases - Categories B, E, G, I, and K.

The orderings of the proposed program aims

As stated earlier, all respondents were asked to rank three possible aims for a general mathematics program from 1 to 3 in order of perceived importance and were asked to rate each of the 90 content items in view of their feelings about the relative importance of the aims. For convenience, the aims are repeated here:

(a) Everyday living: To provide a program which emphasizes the practical, social, and computational aspects or skills which are necessary for everyday living.

(b) Vocational: To provide a program which will give the students the mathematics concepts necessary to enter the workforce and to begin studies at a vocational or trades school in courses which the Provincial Department of Vocational Education has described as requiring one full year of study.

(c) Remedial: To provide a program which will offer remedial work to students who have experienced difficulty with mathematics and will give them the opportunity to achieve success and to return to an academic program (i.e. the present Matriculation program or its equivalent).

In Table 10 are presented the frequencies of the orderings in importance of the three given aims for such a mathematics program as indicated by the whole group of high school teachers. Five respondents did not rank the aims at all. A possible explanation of the 1-1-1 ranking is that the respondents felt that all three aims were equal, and maybe, very important. As for the 1-1-2 and the 1-1-3 rankings the respondents may have considered aim (a) and aim (b) equal, and maybe, very important while aim (c) was secondary, at the most.

Table 10

Frequencies of the Orderings of the Program Aims by HST.

Orderings	2,1,3	1,2,3	2,3,1	3,1,2	1,3,2	3,2,1	1,1,3	1,1,2	1,1,1
Frequency	32	12	1	3	2	1	1	4	3

From the replies of the high school mathematics teachers of mathematics, 50% of them had indicated aim (b) above as the most important, aim (a) as second in importance, and aim (c) as third. This group is hereafter referred to as

HST_{213}. In a later section the group HST_{123} will be considered but no separate analysis will be done on the other orderings due to the small numbers involved.

In Table 11 are presented the frequencies of the indicated orderings of importance of these three aims by the whole group of trades school teachers of mathematics. A possible reasoning for the rankings of 1-1-1, 1-1-2, and 1-2-1 is similar to that given for the HST group. The 2-3-2 ranking may suggest that the individual may not have considered any of the aims primary for such a program and that aim (b) - Vocational - was least in importance. From

Table 11

Frequencies of the Orderings of the Program Aims by TST

Ordering	2,1,3	1,2,3	3,1,2	1,1,2	1,2,1	1,1,1	2,3,2
Frequency	9	2	1	2	1	1	1

the trades school replies about 53% of them had indicated the same ordering of importance of aims as mentioned above for the HST group. That is, they had identified aim (b) as the most important and aim (c) as the least important of the three. This group is hereafter referred to as TST_{213}. No separate analysis will be done for groups other than TST_{213} due to the small numbers of teachers giving these orderings of the aims.

Treatment of the responses for the groups HST_{213} and TST_{213}.

In Table 12 and Table 13 are presented the indices and states of recommendation for each content item relative to its being included in the proposed program as obtained from the responses of the teachers in the groups HST_{213} and TST_{213}, respectively. These were determined in exactly the same manner as for the groups HST and TST (see p.). As seen from these tables there was some disagreement and some agreement between these two groups. In order to gain greater insight into the state of agreement between these two, Tables 14 through 21 were produced to point out the distinguishing features.

In Table 14 are presented the content items from the original list of 90 items which both HST_{213} and TST_{213} recommended as items to be included in the proposed mathematics program.

Upon inspection of Tables 12, 13, and 14 it was observed that among these items about which both groups HST_{213} and TST_{213} agreed to recommend to be included in the program, the difference between the assigned indices for the same item was less than 0.50 for items A2, A3, C10, C12, C13, D17, D18, E32, E37, F42, F45, F52, F54, H60, H61, H62, H63, and K85. These two groups did not agree to recommend the inclusion of any item from Category I (Statistics). Also noted from these three tables was the fact

Table 12

Item Index and Recommendation by HST_{213}

Content Items	Index	Recommendation	Content Items	Index	Recommendation
A1	1.07	Include	F46	1.93	Include
A2	1.06	Include	F47	2.65	Undecided
A3	1.60	Include	F48	2.73	Undecided
A4	3.24	Undecided	F49	2.73	Undecided
B5	2.71	Undecided	F50	3.12	Undecided
B6	3.00	Undecided	F51	2.24	Include
B7	2.76	Undecided	F52	1.47	Include
B8	3.87	Exclude	F53	2.06	Include
C9	1.87	Include	F54	1.29	Include
C10	1.18	Include	G55	2.40	Include
C11	3.13	Undecided	G56	1.94	Include
C12	1.35	Include	G57	2.29	Include
C13	1.33	Include	G58	2.53	Include
D14	3.20	Undecided	G59	3.67	Exclude
D15	3.27	Undecided	H60	1.20	Include
D16	1.80	Include	H61	1.41	Include
D17	1.71	Include	H62	1.53	Include
D18	2.07	Include	H63	1.87	Include
D19	3.13	Undecided	H64	2.82	Undecided
D20	2.60	Undecided	H65	3.06	Undecided
E21	2.47	Include	H66	2.33	Include
E22	2.53	Undecided	H67	2.24	Include
E23	2.47	Include	I68	3.29	Undecided
E24	2.65	Undecided	I69	2.88	Undecided
E25	2.87	Undecided	I70	3.94	Exclude
E26	3.27	Undecided	I71	3.60	Exclude
E27	2.82	Undecided	I72	3.59	Exclude
E28	3.53	Exclude	I73	3.53	Exclude
E29	3.07	Undecided	J74	1.71	Include
E30	3.35	Undecided	J75	1.35	Include
E31	2.24	Include	J76	1.33	Include
E32	1.80	Include	J77	1.47	Include
E33	3.40	Undecided	J78	1.41	Include
E34	2.94	Undecided	J79	1.67	Include
E35	3.06	Undecided	J80	1.40	Include
E36	3.93	Exclude	J81	1.29	Include
E37	2.06	Include	J82	1.33	Include
E38	3.73	Exclude	J83	1.33	Include
E39	3.88	Exclude	K84	2.53	Undecided
E40	3.13	Undecided	K85	2.00	Include
E41	3.00	Undecided	K86	2.82	Undecided
F42	1.47	Include	K87	2.87	Undecided
F43	1.87	Include	K88	2.29	Include
F44	2.35	Include	K89	2.29	Include
F45	1.27	Include	K90	4.07	Exclude

Table 13

Item Index and Recommendation by TST_{213}.

Content Items	Index	Recommendation	Content Items	Index	Recommendation
A1	1.78	Include	F46	1.11	Include
A2	1.22	Include	F47	2.33	Include
A3	1.22	Include	F48	1.33	Include
A4	3.22	Undecided	F49	2.11	Include
B5	3.11	Undecided	F50	2.67	Undecided
B6	3.00	Undecided	F51	1.44	Include
B7	2.89	Undecided	F52	1.33	Include
B8	3.56	Exclude	F53	1.11	Include
B9	1.00	Include	F54	1.11	Include
C10	1.11	Include	G55	1.33	Include
C11	1.22	Include	G56	1.11	Include
C12	1.22	Include	G57	1.56	Include
C13	1.22	Include	G58	1.44	Include
D14	4.11	Exclude	G59	2.44	Include
D15	4.00	Exclude	H60	1.00	Include
D16	1.22	Include	H61	1.11	Include
D17	1.44	Include	H62	1.11	Include
D18	2.11	Include	H63	1.38	Include
D19	3.89	Exclude	H64	2.44	Include
D20	2.1[illegible]	Include	H65	2.00	Include
E21	1.55	Include	H66	1.33	Include
E22	1.44	Include	H67	3.33	Undecided
E23	1.67	Include	I68	4.33	Exclude
E24	2.00	Include	I69	4.00	Exclude
E25	2.33	Include	I70	3.67	Exclude
E26	2.78	Undecided	I71	4.22	Exclude
E27	2.89	Undecided	I72	4.00	Exclude
E28	2.78	Undecided	I73	3.78	Exclude
E29	2.89	Undecided	J74	2.67	Undecided
E30	2.78	Undecided	J75	2.67	Undecided
E31	1.33	Include	J76	3.00	Undecided
E32	1.56	Include	J77	3.00	Undecided
E33	3.44	Undecided	J78	2.78	Undecided
E34	2.00	Include	J79	3.00	Undecided
E35	2.22	Include	J80	3.00	Undecided
E36	3.00	Undecided	J81	2.78	Undecided
E37	1.78	Include	J82	2.33	Include
E38	3.44	Undecided	J83	2.11	Include
E39	3.89	Exclude	K84	2.44	Include
E40	2.44	Include	K85	1.63	Include
E41	3.00	Undecided	K86	3.44	Undecided
F42	1.44	Include	K87	3.11	Undecided
F43	1.33	Include	K88	1.67	Include
F44	1.33	Include	K89	3.00	Undecided
F45	1.22	Include	K90	3.67	Exclude

Table 14

Items Included by HST_{213} and TST_{213}.

Content Items	Description
A1	Performing operations on whole numbers.
A2	Performing operations on integers.
A3	Performing operations on rational numbers.
C9	Computations involving ratios and proportions.
C10	Computing with percent.
C12	Rounding oof numbers.
C13	Converting from one mode of numeral to another.
D16	Finding the GCF of two whole numbers.
D17	Finding the LCM of two whole numbers.
D18	Writing prime factorization of natural numbers.
E21	Knowing the language of algebra (eg. variable).
E23	Knowing and applying the laws of exponents ($a^m . a^n = a^{m+n}$, $a^m \div a^n = a^{m-n}$, $(a^m)^n = a^{mn}$).
E31	Solving linear equations of the type $ax + b = c$; $a, b, c \in I$.
E32	Solving linear equations of the type $ax + b = cx + d$, where $a, b, c, d \in I$.
E37	Solving word problems by using linear equations with one variable.
F42	Studying some basic concepts of geometry (eg. point, line, plane, ray, angle).
F43	Defining and applying types of lines (parallel, intersecting, perpendicular).
F44	Naming and identifying properties of simple plane figures.
F45	Performing basic constructions using pencil, ruler and compass.
F46	Stating and applying the Pythagorean Theorem.
F51	Defining and identifying different types of triangles.
F52	Defining and identifying different types of angles.
F53	Defining and identifying parts of the circle.
F54	Applying formulas for finding perimeter and area of common plane figures (eg. the triangle).
G55	Defining basic trigonometric ratios, relative to the right triangle.
G56	Knowing the relationships among basic trigonometric ratios relative to the right triangle.
G57	Solving right triangles using the basic trigonometric ratios.

Table 14 (continued)

Content Items	Description
H60	Finding and computing with linear measure.
H61	Finding square measure as in the area of common plane figures and solids.
H62	Finding cubic measures as in volume of rectangular solids.
H63	Find and computing with angular measure.
H66	Find measures indirectly by using similar triangles and proportions.
J82	Solving problems dealing with personal earnings.
J83	Making intelligent use of mechanical aids to calculations.
K85	Putting together a logical argument.
K88	Using deductive reasoning.

that in about 86% of the cases the indices for the TST_{213} group were closer to 1 than were those of the HST_{213} group. Only for Items A1, A2, D18, J82, and J83 did these high school teachers provide indices which were closer to 1. As stated earlier, the index 1 indicated a desire to "definitely" include the item while the index 2 indicated the "probability" of inclusion.

In Table 15 are presented the content items for which the calculated indices indicated a state of indecision relative to the inclusion of given items by the group HST_{213} but which indicated a recommendation for inclusion by the group TST_{213}. For items other than Items D20, F47, H64, and K84, the difference between the indices of these groups was greater than 0.50. As with the whole groups, HST and TST, the subgroup TST_{213} favored the inclusion of more algebra topics than did the HST_{213} group. The TST_{213}

Table 15

Items Included by TST_{213}, Undecided by HST_{213}.

Content Items	Description
C11	Solving problems using direct variation.
D20	Writing numerals in scientific notation.
E22	Adding and subtracting non-fractional algebraic expressions (i.e. combining like terms).
E24	Adding and subtracting polynomials in one variable.
E25	Multiplying polynomials (monomials, binomials, trinomials) in one variable.
E34	Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, by the tables of values.
E35	Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, by the slope-intercept method.
E40	Solving systems of linear equations in two variables using the addition and/or substitution method.
F47	Identifying congruent triangles by the SSS, SAS, and ASA conditions.
F48	Applying properties of similar triangles to solve problems.
F49	Applying the Distance Formula.
G58	Solving applied problems using the trigonometric ratios as related to the right triangle.
H64	Finding units of precision and greatest possible error with measures.
H65	Finding relative error and percent of error with measurement.
K84	Making a 'flow chart' organization for problem solving.

group recommended the inclusion of ten algebra items while the HST_{213} group would include only five of the items from this category.

In Table 16 are presented the items which the group HST_{213} recommended for inclusion in the proposed program but about which the group TST_{213} was undecided. For each of these items the difference between the two indices was greater than 0.50; in fact the smallest absolute difference was 0.71 for Item 89. Of particular note here was the tendency of this group of high school teachers to consider the items from business and consumer mathematics as very important, whereas these trades school teachers were uncertain of the necessity to include such topics in this type of mathematics program.

Table 16

Items Included by HST_{213}, Undecided by TST_{213}.

Content Items	Description
H67	Using instruments (eg. transit) to make readings for indirect measure.
J74	Preparing and working on budgets.
J75	Solving problems dealing with installment buying.
J76	Solving problems dealing with buying a car.
J77	Solving problems dealing with buying a home.
J78	Solving problems dealing with borrowing money.
J79	Solving problems dealing with insurance (fire, car, home, life).
J80	Solving problems dealing with personal bank records.
J81	Solving problems dealing with sales and income taxes.
K89	Determining the validity of an argument.

In Table 17 are presented the list of content items about which no decision could be made from the assigned

Table 17

Items Undecided by HST_{213} and TST_{213}.

Content Items	Description
A4	Performing operations on irrational numbers.
B5	Recognizing properties (commutative, associative, distributive, inverses, identities) of whole numbers.
B6	Recognizing properties (commutative, associative, distributive, inverses, identities) of integers.
B7	Recognizing properties (commutative, associative, distributive, inverses, identities) of rational numbers.
E26	Dividing polynomilas having one variable.
E27	Finding common factors for polynomials.
E29	Factoring polynomials of the type $x^2 + bx + c$, where $b, c, \in I$.
E30	Factoring polynomials of the type $ax^2 + bx + c$, where $a, b, c \in I$.
E33	Solving linear inequalities of the type $ax + b > c$ where $a, b, c \in I$.
E41	Recognizing a function from given sets of ordered pairs of numbers.
F50	Finding the coordinates of the midpoint of a segment.
K86	Disproving a statement by counterexample.
K87	Proving a simple theorem.

indices for either group. Except for Item E30 and Item K86, the differences in the indices were less than 0.50. For these two items, the differences were 0.57 and 0.64, respectively. The major categories which produced indecision as to their inclusion in the program were those dealing with properties and algebra.

The content items whose indices yielded the recommendation to exclude them from the proposed mathematics program by both the HST_{213} and the TST_{213} group are presented in Table 18. The absolute difference between the indices for Item I71 was 0.62, while for each of the others it was less than 0.42. This showed a strong agreement between two groups for these items. Both groups felt that two-thirds of the items in the Statistics category should not be part of the course of studies for this mathematics program. The remaining one-third of these items were recommended for exclusion by the TST_{213} group, but the HST_{213} group was uncertain about the question of inclusion

Table 18

Items Excluded by HST_{213} and TST_{213}

Content Items	Description
B8	Recognizing properties (commutative, associative, distributive, inverses, identities) of irrational numbers.
E39	Graphing inequalities of the type ax > by + c, a, b, c ∈ I.
I70	Calculating measures of central tendancy (mean, mode, median, skewness).
I71	Calculating percentiles in statistical data.
I72	Calculating measures of dispersion (range, variation, standard deviation).
I73	Probability (concept of probability, approaches to it).
K90	Studying the history of mathematics.

In Table 19 are presented the content items whose assigned indices brought the recommendation for exclusion from the group HST_{213} while the TST_{213} group was undecided about the inclusion. Here again the high school teachers indicated their opinion that algebra does not play a particularly important role for this type of mathematics program. They recommended the exclusion of three of the algebra content items and, as seen in Tables 15 and 17, they were uncertain relative to the inclusion of twelve other items from the Algebra Category.

The items about which TST_{213} favored exclusion and HST_{213} was undecided are listed in Table 20. Three of these five items belong to the Category of Number Theory while the other two belong to Statistics. With the exception of Item E38, the absolute difference between the indices was greater than 0.50.

Table 19

Items Excluded by HST_{213}, Undecided by TST_{213}.

Content Items	Description
E28	Factoring polynomials of the type $a^2x^2 - c^2$, $a, c \in I$.
E36	Solving quadratic equations of the type $ax^2+bx+c=0$, $a,b,c \in I$, by the Quadratic Formula.
E38	Graphing quadratic equations of the type $y = ax^2 + bx + c$ where $a,b,c \in I$.

The analysis showed no content items which were recommended for inclusion in this mathematics program by

Table 20

Items Excluded by TST_{213}, Undecided by HST_{213}.

Content Items	Description
D14	Naming the union and intersection of given sets.
D15	Defining and naming subsets of given sets.
D19	Finding the absolute value of rational numbers.
I68	Distinguishing between descriptive and inferential statistics.
I69	Writing frequency distributions and graphing them.

HST_{213} and for exclusion by TST_{213}. Only Item G59 (defining basic trigonometric ratios using the unit circle) was recommended for inclusion by TST_{213} and for exclusion by HST_{213}.

In Table 21 are given the average rating or index for each of the eleven categories of content items as provided by the HST_{213} and the TST_{213} groups. Also provided are the accompanying recommendations as determined from these indices. This information indicated that these two groups of mathematics teachers agreed in their recommendations to include Category A (Performing operations), Category C (Arithmetic computation), Category F (Geometry), and Category H (Measurement). They were also in agreement in their uncertainity about including Category B (Recognizing properties) and Category K (Logic). The two indices for each category were especially close for Categories A,B,D, H, and K. There was some disagreement between the two

Table 21

Averaged Category Index and Recommendation by HST_{213} and TST_{213}

Category of Items	Average rating by HST_{213}	TST_{213}	Recommendation by HST_{213}	TST_{213}
A-Performing Operations	1.74	1.86	Include	Include
B-Recognizing Properties	3.09	3.14	Undecided	Undecided
C-Arithmetic Computation	1.77	1.15	Include	Include
D-Number Theory	2.54	2.70	Undecided	Undecided
E-Algebra	2.99	2.44	Undecided	Include
F-Geometry	2.09	1.53	Include	Include
G-Trigonometry	2.57	1.58	Undecided	Include
H-Measurement	2.06	1.71	Include	Include
I-Statistics	3.47	4.00	Undecided	Exclude
J-Business and Consumer Mathematics	1.43	2.73	Include	Undecided
K-Logic	2.70	2.71	Undecided	Undecided

groups on Category E (Algebra), Category G (Trigonometry) and Category J (Business and Consumer Mathematics).

Treatment of the responses for the groups HST_{213} and HST_{123}.

Other than these two subgroups of teachers mentioned above there was only one other where the frequency of the same ranking of the three aims was relatively substantial in number. There were 12 high school teachers who ranked the three aims in the order 1, 2, and 3; that is, they classified aim (a) - Everyday living - as most important, aim (b) - Vocational - as second in importance, and aim (c) - Remedial - as third in importance. (This group will be referred to as HST_{123}). In Table 22 are presented the indices to the content items as derived from the analysis of the ratings by the respondents and recommendations relative to the question of including these items in the proposed mathematics program. These were determined by the same procedure as for the other groups (see p. 46). In order to determine the state of agreement between the two subgroups of high school teachers - HST_{213} and HST_{123} - Tables 12 and 22 were compared.

In Table 23 are presented the content items which were recommended to be included in the proposed program by both these groups. Of those 33 items, it was observed that for Items A1, A2, A3, C10, C12, C13, D16, D17, F42, F43, F46, F52, F54, H60, H61, H62, J75, J77, J78, J80, J81, J82, J83, K88, and K89 the differences between the indices assigned by HST_{213} and HST_{123} were less than 0.50. Ten of these 33 items belonged to the Category J (Business and Consumer Mathematics) while eight others belonged to Category F (Geometry). There was no agreement between HST_{213} and HST_{123} in recommending the inclusion of items from Category E (Algebra). HST_{123} did not assign ratings which allowed for recommending the inclusion of any items from

Table 22

Item Index and Recommendation by HST_{123}

Content Items	Index	Recommendation	Content Items	Index	Recommendation
A1	1.17	Include	F46	2.17	Include
A2	1.33	Include	F47	3.33	Undecided
A3	1.33	Include	F48	2.83	Undecided
A4	3.66	Exclude	F49	2.33	Include
B5	2.67	Undecided	F50	4.50	Exclude
B6	3.17	Undecided	F51	2.67	Undecided
B7	3.33	Undecided	F52	1.83	Include
B8	2.83	Undecided	F53	2.00	Include
C9	1.33	Include	F54	1.33	Include
C10	1.00	Include	G55	3.00	Undecided
C11	2.67	Undecided	G56	2.83	Undecided
C12	1.09	Include	G57	2.67	Undecided
C13	1.17	Include	G58	2.83	Undecided
D14	2.33	Include	G59	4.00	Exclude
D15	2.17	Include	H60	1.67	Include
D16	1.33	Include	H61	1.50	Include
D17	1.50	Include	H62	1.83	Include
D18	1.33	Include	H63	3.17	Undecided
D19	3.00	Undecided	H64	3.50	Undecided
D20	2.50	Undecided	H65	2.83	Undecided
E21	3.17	Undecided	H66	2.50	Undecided
E22	4.00	Exclude	H67	2.50	Undecided
E23	3.83	Exclude	I68	3.50	Undecided
E24	3.67	Exclude	I69	2.83	Undecided
E25	3.83	Exclude	I70	3.33	Undecided
E26	3.67	Exclude	I71	3.33	Undecided
E27	4.33	Exclude	I72	4.00	Exclude
E28	4.83	Exclude	I73	3.50	Undecided
E29	3.50	Undecided	J74	1.00	Include
E30	4.83	Exclude	J75	1.17	Include
E31	2.83	Undecided	J76	1.00	Include
E32	3.17	Undecided	J77	1.17	Include
E33	2.50	Undecided	J78	1.17	Include
E34	3.17	Undecided	J79	1.17	Include
E35	4.00	Exclude	J80	1.33	Include
E36	4.00	Exclude	J81	1.17	Include
E37	3.00	Undecided	J82	1.00	Include
E38	4.00	Exclude	J83	1.33	Include
E39	4.83	Exclude	K84	3.33	Undecided
E40	3.17	Undecided	K85	2.67	Undecided
E41	4.50	Exclude	K86	3.83	Exclude
F42	1.67	Include	K87	2.83	Undecided
F43	2.33	Include	K88	2.33	Include
F44	1.50	Include	K89	2.00	Include
F45	1.83	Include	K90	3.50	Undecided

Table 23

Items Included by HST_{123} and HST_{213}

Content Items	Description
A1	Performing operations on whole numbers.
A2	Performing operations on integers.
A3	Performing operations on rational numbers.
C9	Computation involving ratios and proportions.
C10	Computing with percent.
C12	Rounding off numbers.
C13	Converting from one mode of numeral to another.
D16	Finding the G.C.F. of two whole numbers.
D17	Finding the L.C.M. of two whole numbers.
D18	Writing prime factorization of natural numbers.
F42	Studying some basic concepts of geometry (eg. point, line, plane, ray, angle).
F43	Naming and applying types of lines (perpendicular, parallel, intersecting).
F44	Naming and applying properties of simple plane figures.
F45	Performing basic constructions using ruler, pencil and compass.
F46	Stating and applying the Pythagorean Theorem.
F52	Defining and identifying different types of triangles.
F53	Defining and identifying different types of angles.
F54	Defining and identifying parts of the circle.
H60	Finding and computing with linear measure.
H61	Finding square measure as in area of common plane figures and solids.
H62	Finding cubic measures as in volume of rectangular solids.
J74	Preparing and working on budgets.
J75	Solving problems dealing with installment buying.
J76	Solving problems dealing with buying a car.
J77	Solving problems dealing with buying a home.
J78	Solving problems dealing with borrowing money.
J79	Solving problems dealing with insurance (life, fire, car, home).
J80	Solving problems dealing with personal bank records.
J81	Solving problems dealing with sales and income taxes.
J82	Solving problems dealing with personal earnings.
J83	Making intelligent use of mechanical aids to calculations.
K88	Using deductive reasoning.
K89	Determining the validity of an argument.

Algebra in this program while HST_{213} recommended the inclusion of only five items from this category.

The group HST_{123} seemed a little more definite than the group HST_{213} about their decision on the question of including items in about 61% of the cases. This was observed by noting the difference between the indices and the index 1. Except for item J83, the HST_{123} group was more definite than the HST_{213} group in deciding to include the Category J (Business and Consumer Mathematics). The index for Item J83 (pertaining to mechanical aids to calculation) was 1.33.

In Table 24 are presented the content items where the assigned indices called for the recommendation for inclusion by the HST_{213} group but no decision by the HST_{123} group. Of the items about which these two groups of high school teachers did not agree, four of them belonged to the Category of Algebra and three belonged to the Category of Trigonometry. In Table 25 are presented the items recommended for inclusion by the group HST_{123} but about which the group HST_{213} was undecided. For Items F49, F51, G57, H66, and H67 the absolute difference between each pair of indices was less than 0.50 while the other items in these tables show a difference of greater than 0.50.

In Table 26 are presented the six items which both the HST_{213} and HST_{123} groups recommended to be excluded

Table 24

Items Included by HST_{213}, Undecided by HST_{123}

Content Items	Description
E21	Knowing the language of algebra (eg. variable).
E31	Solving linear equations of the type ax b c, where a,b,c I.
E32	Solving linear equations of the type ax b cs d; where a,b,c,d I.
E37	Solving word problems using linear equations with one variable.
F51	Defining and identifying different types of triangles.
G55	Defining basic trigonometric ratios using the right triangle.
G56	Knowing the relationships among the basic trigonometric ratios relative to the right triangle.
G57	Solving right triangles using the basic trigonometric ratios.
G58	Solving applied problems using the trigonometric ratios as related to the right triangle.
H63	Finding and computing with angular measure.
H66	Finding measures indirectly by using similar triangles and proportions.
H67	Using instruments (eg. the transit) to make readings for indirect measure.
K85	Putting together a logical argument.

Table 25

Items Included by HST_{123}, Undecided by HST_{213}

Content Items	Description
D14	Naming the union and intersection of given sets.
D15	Defining and naming subsets of given sets.
F49	Applying the Distance Formula.

from the proposed program. Four of these items belonged to the Category of Algebra.

Table 26

Items Excluded by HST_{213} and HST_{123}.

Content Items	Description
E28	Factoring polynomials of the type $a^2x^2 - c^2$, $a, c \in I$.
E36	Solving quadratic equations of the type $ax^2 + bx + c = 0$, where $a, b, c \in I$, by the Quadratic Formula.
E38	Graphing quadratic equations of the type $y = ax^2 + bx + c$, where $a, b, c \in I$.
E39	Graphing inequalities of the type $ax > by + c$; $a, b, c \in I$.
G59	Defining basic trigonometric ratios using the unit circle.
I72	Calculating measures of dispersion (range, variation, standard deviation).

The content items about which neither group could make a decision concerning the question of inclusion are presented in Table 27. Of these 18 items, four belonged to the Category of Algebra. With five of them, the absolute difference between the pair of indices was greater than 0.50, while for the other 14 items the differences were less than 0.50. This seemed to show a fair degree of agreement between these two groups of high school teachers.

In Tables 28 and 29 are presented the content items where one of these groups of high school teachers was

Table 27

Items Undecided by HST_{213} and HST_{123}

Content Items	Description
B5	Recognizing properties (commutative, associative, distributive, inverses, identities) of whole numbers.
B6	Recognizing properties (commutative, associative, distributive, inverses, identities) of integers.
B7	Recognizing properties (commutative, associative, distributive, inverses, identities) of rational numbers.
C11	Solving problems using direct variation.
D19	Finding the absolute value of rational numbers.
D20	Writing numerals in scientific notation.
E29	Factoring polynomials of the type $x^2 + bx + c$; $b, c \in I$.
E33	Solving linear inequalities of the type $ax + b > c$, where $a, b, c \in I$.
E34	Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, using tables of values.
E40	Solving systems of equations in two variables by the substitution and/or addition method.
F47	Identifying congruent triangles by the SSS, ASA and SAS conditions.
F48	Applying properties of similar triangles to solve problems.
H64	Finding units of precision and greatest possible error in measures.
H65	Finding relative error and percent of error in measures.
I68	Distinguishing between descriptive and inferential statistics.
I69	Using frequency distributions and graphing them.
K84	Making a 'flow chart' organization for problem solving.
K87	Proving a simple theorem.

undecided in their recommendation while the other recommended the exclusion of the items. From this list of 19 items eight belonged to the Category of Algebra, and three be-

Table 28

Items Excluded by HST_{123}, Undecided by HST_{213}.

Content Items	Description
A4	Performing operations on irrational numbers.
E22	Adding and subtracting non-fractional algebraic expressions (i.e. combining like terms).
E24	Adding and subtracting polynomials in one variable.
E25	Multiplying polynomials (monoials, binomials, trinomials) in one variable.
E26	Dividing polynomials having one variable.
E27	Finding common factors for polynomials.
E30	Factoring polynomials of the type $ax^2 + bx + c$; $a, b, c \in I$.
E35	Graphing linear equations of the type $y = ax + b$; $a, b \in I$. by the slope-intercept method.
E41	Recognizing a function from given sets of ordered pairs of numbers.
F50	Finding the coordinates of the midpoint of a segment.
K86	Disproving a statement by a counterexample.

Table 29

Items Excluded by HST_{213}, Undecided by HST_{123}.

Content Items	Description
B8	Recognizing properties (commutative, associative, distributive, inverses, identities) of irrational numbers.
I70	Finding measures of central tendancy (mean, mode, median, skewness).
I71	Calculating percentiles in statistical data.
I73	Probability (concept of randomness, approaches to probability).
K90	Studying the history of mathematics.

longed to the Category of Statistics. With the exception of Items A4, E26, I71, and I73 the absolute difference between the assigned indices was greater than 0.50. For Item I73 (pertaining to probability), even though their recommendations did not agree, there was a difference of only 0.03 in the indices.

There was one item - Item E23 (knowing and applying the laws of exponents) - which was recommended for inclusion in the program by HST_{213} but for exclusion by HST_{123}. HST_{213} did not recommend the exclusion of any item which was recommended for inclusion by HST_{123}.

In Table 30 are presented the average index given each of the eleven categories by the groups HST_{213} and HST_{123} as well as a recommendation identified from the indices relative to the inclusion of each category. There was agreement to include Category A (Performing operations) Category C (Arithmetic Computation), Category H (Measurement), and Category J (Business and Consumer Mathematics). For these four categories the differences between the calculated indices were relatively small, each being less than 0.40. The indices showed that these groups also agreed in their states of indecision concerning Category B (Recognizing Properties), Category I (Statistics), and Category K (Logic). Here again the differences between the calculated indices were relatively small; they were 0.09, 0.50, 0.05 and 0.23 for these categories, respectively. The group

Table 30

Averaged Category Index and Recommendation by HST_{213} and HST_{123}

Category of Items	Average rating by HST_{123}	Average rating by HST_{213}	Recommendation by HST_{123}	Recommendation by HST_{213}
A-Performing Operations	1.88	1.74	Include	Include
B-Recognizing Properties	3.00	3.09	Undecided	Undecided
C-Arithmetic Properties	1.43	1.77	Include	Include
D-Number Theory	2.02	2.54	Include	Undecided
E-Algebra	3.73	2.99	Exclude	Undecided
F-Geometry	2.77	2.09	Undecided	Include
G-Trigonometry	3.07	2.57	Undecided	Undecided
H-Measurement	2.44	2.06	Include	Include
I-Statistics	3.42	3.47	Undecided	Undecided
J-Business and Consumer Mathematics	1.15	1.43	Include	Include
K-Logic	2.93	2.70	Undecided	Undecided

HST_{213} was undecided about Category E (Algebra) while HST_{123} recommended its exclusion from the proposed mathematics program. These two groups did not agree about Category F (Geometry) in that HST_{213} recommended its inclusion while HST_{123} was undecided about its placement. Both groups were undecided about the inclusion of Trigonometry, although the index for HST_{213} was 2.57, which was more favorable for inclusion that the HST_{123} index of 3.07.

Ordering of the aims by the HST group relative to their ages, training and experience

In Tables 31, 32, 33, 34, and 35 the rankings of the program aims as given by the high school teachers are given in relationship to their academic training, their ages, their teaching experiences, their teacher-grade certificates, and their experiences teaching non-academic mathematics, respectively. The fact that none of the percentages for any grouping totals 100 percent is because not every teacher selected a single aim to rank 1. A few, for example, indicated that the "Everyday Living" aim and the "Vocational" aim ranked equally as 1. (See Tables 10 and 11). Therefore since some respondents did not supply the information in the manner required for the analysis there are discrepancies between the total percentages and 100 percent.

These five tables indicate that the high school teachers, regardless of which variable concerning age or experience was considered, generally felt that the most important aim for a non-university program is the Vocational aim. Very few felt that the Remedial aim played a significant role. The only group that did pay much attention to that aim was the high school teachers having a teaching certificate of Grade IV or less. But even this only accounted for 2 respondents.

It was noted that, even though the Vocational aim was ranked 1 most frequently, the teachers with fewer

Table 31

Academic Training of HST as Compared to their Ranking of the Program Aims.

Number of mathematics courses completed	Number of teachers	Percentage of teachers favoring aim (a) "Everyday Living"	Percentage of teachers favoring aim (b) "Vocational"	Percentage of teachers favoring aim (c) "Remedial"
Less than 6	16	18	44	6
6 - 11	19	21	62	5
12 or more	28	22	52	0

Table 32

Ages of HST as Compared to their Ranking of the Program Aims.

Age groups	Number of teachers	Percentage of teachers favoring aim (a) "Everyday living"	Percentage of teachers favoring aim (b) "Vocational"	Percentage of teachers favoring aim (c) "Remedial"
Under 30 years	22	28	52	4
30 - 39	29	30	42	3
40 or older	10	30	50	0

Table 33

Teaching Experience of HST is Compared to their Ranking of the Program Aims.

Number of years teaching	Number of teachers	Percentage of teachers favoring aim (a) "Everyday living"	Percentage of teachers favoring aim (b) "Vocational"	Percentage of teachers favoring aim (c) "Remedial"
Less than 5 years	6	17	67	0
5 - 10 years	24	30	63	0
More than 10 years	32	22	47	6

Table 34

Teaching Grade-Certificate of HST as Compared to their Ranking of the Program Aims.

Grade Certificate	Number of teachers	Percentage of teachers favoring aim (a) "Everyday living"	Percentage of teachers favoring aim (b) "Vocational"	Percentage of teachers favoring aim (c) "Remedial"
I - IV	8	25	38	25
V	19	26	53	0
VI	28	18	57	0
VII	9	11	55	0

Table 35

Non-Academic-Teaching Experience of HST is Compared to their Ranking of the Program Aim.

Number of years teaching non-academic mathematics.	Number of teachers	Percentage of teachers favoring aim (a) "Everyday living"	Percentage of teachers favoring aim (b) "Vocational"	Percentage of teachers favoring aim (c) "Remedial"
0 - 4 years	36	11	61	0
5 or more years	25	28	48	8

years teaching experience emphasized its importance more so than teachers with more such experience.

Teacher opinions relative to the need for a general program

Some respondents stated their personal opinions regarding the need for such a mathematics program as described. (See Appendices H and I). In summary, some of the most frequently stated views were:

1. There is a definite need for such a program.

2. High school teachers generally favored a consumer oriented program.

3. Trades school teachers generally indicated the need for a program which would emphasize and guarantee students' proficiency in the "basics" (eg. fractions, decimals, percents).

4. Teachers generally felt that the non-university capable student has been far too much neglected by curriculum decision makers.

5. The present Basic Program in Newfoundland high schools fails to fulfil the needs of this type of mathematics student.

Summary

High school and trades school teachers generally indicated a need for the general students to become capable of correctly performing operations, particularly on the whole, integral and rational numbers. They recommended that these students should be functional with arithmetic computation and to be able to apply the same to business and consumer material. A competence with various measurements and a general knowledge of common geometric topics appeared as viable areas of study to be included in this program. The groups - HST, HST, HST_{123}, HST_{213}, and TST_{213} - did not support these views with the same degree of positive opinion, but they were inclined to include several items from those categories.

On the other hand, no group felt that statistics, logic, or recognition or mathematical properties offerred suitable material for a general mathematics program. Trades school teachers, in general, had greater preference than did high school teachers for algebraic items to be included in such a program. In Chapter V is presented more thorough discussion on the observations arising from this chapter.

CHAPTER V

SUMMARY AND CONCLUSIONS

In this chapter an overview of the problem under investigation, the instruments involved in the collection of the data, the population with which the study was concerned, and the analysis of the data are presented. Conclusions arising out of the findings of the study are presented. Furthermore, some discussion relating to possible implications and suggestions for further research is presented.

Summary of the Investigation

The study was developed primarily to compare the perceptions of teachers of mathematics from district vocational (trades) schools and from high schools in Newfoundland relative to the inclusion of certain content items in a general mathematics program. From these perceptions a common core of items was identified which could be recommended for such a program for grades 9, 10, and 11 in the province's high schools. In addition, attempts were made to determine the relative importance of these content items as perceived by these concerned groups with reference to their rankings of three stated aims of such a program.

Questions explored

To achieve the purpose mentioned above, answers to the following questions were sought:

(1) Which content items from the 90 listed were recommended for inclusion by the high school teachers? by the trades school teachers?

(2) On what content items was there agreement between these two groups of teachers?

(3) What content items are important to one group of teachers but not to the other?

(4) What content items are important or unimportant to subgroups of these teachers according to their orderings of the stated aims of the program.

(5) How do the indicated ratings of importance of the content items as perceived by these two groups compare?

(6) Are there any observable differences in the views of high school teachers relative to their ages, university training, teaching experiences, teaching-grade certificates, and experiences with non-academic mathematics?

The instruments

In order to gather the necessary information, an appropriate instrument was devised. Following a survey of literature and studies pertinent to the mathematical content for general programs, an initial instrument was produced. After consultation with several mathematics educators in order to assess the validity, a final instrument was prepared. This was a questionnaire containing 90 items which represented eleven different content areas in mathematics. This questionnaire was then divided into two forms, each of which was assigned randomly 45 items from the list of 90. The items were numbered from 1 to 45 on each questionnaire and were not grouped or identified relative to the mathematical category as on the complete list of 90 items. They were forwarded to the teachers involved in the study.

Samples

The two populations were teachers of mathematics in the high schools and trades schools of Newfoundland. The samples included teachers from 25 high schools representing most geographical areas of the province and from 16 of the provinces district vocational schools. Replies were received from 23 of the 25 high schools contacted for a total of 64 respondents and from 14 of the 16 district vocational schools for a total of 17 respondents.

Analysis

Upon return of the questionnaires, the content items from the two forms were regrouped to make the original form of 90 items in eleven categories. The ratings given each item were multiplied by the number of respondents giving these ratings. These products were totaled and divided by the toal number of respondents for each item. Based on these resulting indices, a recommendation relative to the inclusion of each item was made.

Three aims for a general program were ranked from 1 to 3 in order of importance by the respondents. Major subgroups of the trades and high school teachers were identified as based on the most common orderings of the aims. Recommendations concerning the inclusion of each item were determined for these subgroups in the same manner as for the whole groups.

Conclusions

Comparisons of the ratings of the content items and the rankings of the three stated program aims did not show total agreement nor total disagreement. The most common orderings of the aims relative to importance as perceived by the majority of the high school teachers and the trades school teachers was (1) Vocational aim, (2) Everyday Living aim and (3) Remedial aim. These groups have been referred to as HST_{213} and TST_{213}. The other orderings of the importance of the aims which occurred fairly frequently among the high school teachers was (1) Everyday Living aim, (2) Vocational aim and (3) Remedial aim. This group has been referred to as HST_{123}.

The trades school and the high school teachers were generally undecided about the inclusion of all items concerning the recognition of properties. This may have been the result of their misinterpreting the category to mean memorizing the properties. Another possible explanation is that teachers felt that emphasis should be placed on preparing the students on such a program to obtain answers without much concern for why things turn out as the answers show; that is, they may have indicated a preference to train those students to perform and not to educate them in the discipline of mathematics in the purest sense.

All teachers were in agreement concerning Category A. This indicated that they felt the students on a general program should be prepared to adequately perform operations with whole, integral and rational numbers. However, they did not favor the inclusion of irrational numbers. The implication seemed to be that trades and high school teachers do not see any practical value for these students to manipulate irrational numbers, but that rationals play an important role in their future career development.

In general, the trades and high school teachers felt that Business and Consumer Mathematics was worth including in a general mathematics program. The high school teachers, though, gave ratings for these items which suggested that they felt more strongly than did trades school teachers concerning the inclusion of this category. This was demonstrated by the fact that TST_{213}, the only group involved who did not clearly favor its inclusion, was undecided about 8 of the 10 items. It appeared that this group was unsure of the role Business and Consumer Mathematics plays as they considered the Vocational aim as of prime importance. Even though most respondents felt the same way about this aim, they indicated that a primary concern of high schools is to graduate students with a functional ability in such areas as those in this category, and that a mathematics program is the appropriate place to convey this knowledge. The group HST_{123}, who had ranked the Everyday Living aim as most important, appeared more definite in their approval of the Business and Consumer Mathematics category than any other group. High school teachers who ranked the Vocational aim as most important had a tendancy here to lean toward the views of the vocational school teachers. In these cases their views seemed consistent with their rankings of the program aims.

The category of Geometry yielded agreement among all the groups of teachers in approximately 80% of the cases. They favored the inclusion of most of the items; in fact, the trades school teachers included all but one item. This indicated that teachers felt geometry, especially of the type suggested by this study, plays a particularly important role in the lives of these students and, therefore, their program should include its study.

There was a similar degree of agreement among the respondents for Category C (Arithmetic Computation) where they recommended the inclusion of most items. This was true for all groups. The trades school teachers who are quite familiar with trades school programs felt that this category deserved attention in school. The high school teachers agreed with them.

Another category which brought a fair degree of agreement was the one on measurement. Here though the trades school teachers appeared to see a greater need for those students to study these items than did high school teachers. In a similar manner, high school teachers who ranked the Vocational aim as first in importance (ie. HST_{213}) tended to agree with the greater emphasis placed by the trades school teachers on this category. This implied that these high school teachers and the TST group felt that the general students should be taught measurement-related material as suggested by this study. The other teachers did not argue against this view, but they were not so emphatic about it.

The category that yielded the least agreement was Category E (Algebra). The trades school teachers, particularly TST_{213}, favored the inclusion of more algebra than did high school teachers. In fact, the groups HST_{213} and HST_{123} did not agree on the inclusion of any of the algebraic items, but HST_{213} tended to favor more algebra than did HST_{123}. Here again, HST_{213} and the trades school teachers had some common core of views which was not surprising when the ranking of the aims is considered. It seemed that the trades school teachers and those giving importance to the Vocational aim felt that algebra is a relatively importance area for a general program. Trades school teachers are dealing with students who are actually training for vocations, and they thereby see the immediate need for the algebraic items in their preparation.

On the other hand, the high school teachers might not be so assured of the need for algebra for those students. Their students move on to other avenues as well as trades schools. In fact, some of their students may not be capable of becoming skilled craftsmen. Therefore, the high school teachers may have recognized a greater limitation in the abilities of these students and a lesser need for them to study and use more advanced mathematics than did the trades school teachers. From all the students whom the high school teachers instruct, the trades school teachers deal only with those who, first, are qualified to enter their institutions and, secondly, are selected from those applying for entry by being among the better qualified applicants. This quite possibly gives a different perspective to the view of the need for algebra.

Category I (Statistics) presented an area where most of the respondents favored either excluding the items from the program or were undecided about the whole question of inclusion. Generally, trades school teachers tended to propose the exclusion of statistics while high school teachers ranged from being undecided to recommending exclusion. It appeared that teachers in the trades school and the high schools do not consider any items from the proposed list of items for this category as basic material while everyone, including those on a general mathematics program, should study. This presents views with which proponents of positions such as that expressed by the NCSM paper on basic skills (National Council of Supervisors of Mathematics, 1977) might argue. However, the groups involved in this study appeared to consider statistics as materials that bears very little practical relevance to the lives of general students.

There was some disagreement between trades school and high school teachers concerning trigonometry, in that the former tended to propose the inclusion of most of the items in the category while the latter were somewhat more undecided. The group HST_{213} once again tended to agree with the trades school teachers, for they recommended the inclusion of most of the trigonometric items. This group of high school teachers, to a great extent, reflected the views of trades school teachers more so than other high school teachers did. This was not unexpected, since they considered the Vocational aim as having greatest influence on a non-university preparatory program.

On an average, the groups were in agreement concerning Category D (Number Theory) in about 50% of the cases, and most of the time this agreement reflected the opinion for including the items. The high school teachers, particularly HST_{123}, tended to favor these items more than did the trades school teachers. This group which emphasized the Everyday Living aim possibly felt the items in this category were of a practical nature and fitted in well with the computational skills necessary in everyday living. The other teachers probably considered the items as not playing a particularly significant role in preparing students for the workforce or for further training.

For the category of Logic there was agreement among the groups for more than half the items, with less than half of these being recommended for inclusion in the program. Generally the teachers were undecided or tending toward exclusion of these items. This possibly was due to the teachers misunderstanding the items themselves where they may have a pre-conceived and a misconceived interpretation of the concept 'logic'. But, of course, the reason may have been simply that teachers were not enthused about including logic in this type of program.

As noted in Tables 12, 13, and 21, there were several differences in the recommendations concerning certain content items for the groups HST_{213} and TST_{213}, despite their common ranking of the program aims. It seemed that the TST_{213} group, like most trades school teachers, placed more emphasis then the HST_{213} group on algebra, trigonometry, and geometry in order that such a general program would adequately satisfy the Vocational aim. The HST_{213} group appeared to want to give a lesser amount of this type of mathematics to the general student and to emphasize the role of businesss and consumer oriented material as of key importance. So even though there was the same overall view of the main purposes of the general program, the TST_{213} group placed more importance on the preparation of the students to enter the trades schools then did the HST_{213} group who wanted to provide this preparation, but to give a greater awareness to preparing the general students to enter the workforce and to be educated consumers.

Table 30 showed similarity between the averaged indices given by the groups HST_{123} and HST_{213} despite their different rankings of the program aims. There was a slightly different stress placed by HST_{213} on operations, algebra, geometry, trigonometry, and measurement. This might have been expected from their ranking of the aims, but this table did not show any major differences in the category indices as obtained from the responses of HST_{123} and HST_{213}. The explanation probably rests with the view that high school teachers generally felt that there is a greater need to prepare the general students to enter the workforce as an educated consumer than there is to be concerned about studying pure mathematics such as algebra.

High school teachers may feel that such mathematics, with adequate emphasis on consumer and business material, will give the general student a sufficient preparation for entering trades schools and that in these schools they will learn how to apply the mathematics needed for the specific trades.

Trades school teachers appeared somewhat more definite than high school teachers in their opinion for approximately three times as many items. This was noted by the fact that their ratings were closer to 1 or to 5 than the corresponding ratings for the high school teachers. This was possibly due to the trades school teachers being very cognizant of the fact that they were preparing people for specific roles. They must teach the mathematics that is necessary for, and is utilized by, people in these trades. Therefore, the mathematics in their courses is set to meet these specific needs. High school teachers, however, prepare students for entry into a greater multitude of roles than those offerred by the trades schools. They teach mathematics for an extremely wide range of endeavours and not for a limited number of specific roles. This could contribute to their being somewhat less ardent in their opinions on including or excluding given items in this study.

There are two main philosophies of thought concerning the general program and they are illustrated by the groups HST_{123} and HST_{213}. One is a view to preparing the students to become educated to use mathematics in everyday life. The other is to prepare them for work - directly or indirectly through vocational training. A major problem for curriculum decision makers appears to be one of finding a balanced or reasonable compromise between these two views. Stemming from this controversy are arguments such as those for more algebra, as demonstrated by HST_{213}, and for more consumer-oriented material as given by HST_{123}.

From all the teachers involved in this study, only five considered as the most important aim that which would provide a program promoting remedial work and a return to an academic program. This seemed to suggest that teachers generally have adopted the premise that there are students who are unable to cope with an academic program and, therefore, a non-academic program is necessary for secondary schools. An implication of this may be that curriculum decision makers should not conern themselves so much with providing programs which are designed so that students can transfer in a two-way direction (i.e. to and from an academic program) but more on providing non-university preparatory program (s) which exist independent of academic courses. This study revealed that the greatest concern of the majority of teachers involved was to provide a program for the general student which prepares them to enter the work-force or a trades school. This, along with their apparent lack of concern for remediation programs, has great implications for the curriculum. It appeared that those teachers generally want a program which advance them in the discipline of mathematics and simply does not sharpen arithmetic skills only. An inference from the study might be that many teachers, especially trades school teachers, wish to find a program that contains content which is more challenging than that found in the Basic Program but less challenging than that of the Matriculation Program used in Newfoundland high schools.

It appeared that there was a discrepancy between what high school teachers and trades school teachers consider as essential to a mathematics program for the general students. As indicated earlier, the answer may rest partially with the student populations themselves. The high school teachers are geared to prepare students to enter training in numerous vocations as well as to be able to function adequately in today's society, whereas the trades school teachers seek to prepare students for specific trades. Nevertheless, those two particular groups of teachers do teach some of the same students, so their efforts need to have as much common direction as possible. If the trades school teachers generally feel that algebra is important to the training of future skilled craftsmen, then the curriculum decision makers should give serious consideration to including it in a general mathematics program. Otherwise, the trades schools might consider making the Matriculation Program a prerequisite to more of their courses.

The average age of the high school teachers involved in this study was approximately 34 years and their average number of years of university training was 5.5 years. These data were similar to the same for the group HST, HST_{213}, HST_{123}, TST, and TST_{213}. Generally, the high school teachers seemed well qualified and had completed some studies at a university fairly recently. A major trend among these high school teachers, regardless of which characteristic (see Tables 32 - 35) was observed, was that the most common view of the aims for a non-university preparatory mathematics program was that as illustrated by the HST_{213} group.

Some differences, though, were observed. Only 11 percent of high school teachers holding a Grade VIII teaching certificate and only 11 percent of those having taught general mathematics for five years or more ranked the Everyday Living aim as most important. Generally, the percentage of high school teachers ranking this aim as 1 ranged from 20 percent to 30 percent. While most high school teachers gave little importance to the Remedial aim, 25 percent of these teachers having teaching certificates of Grade IV or less ranked the aim as first. These mentioned differences were not tested statistically so they may not be significant but they did show up in the analysis.

Otherwise, there did not appear to be any major differences in the ranking of the program aims by high school teachers when this was compared with other teacher characteristics.

In summary, the main conclusions drawn from this study are:

1. There was a degree of disagreement between the ratings and the indices given the content items by the high school and the trades school teachers. Generally, the trades school teachers seemed to indicate that the category of Arithmetic Computation was most important for a general mathematics program. The other categories indicated as very important by the trades school teachers were (a) Performance of Operations on whole numbers, integers, and rational numbers, (b) Geometry, (c) Trigonometry, and (d) Measurement. They also indicated that the category of Business and Consumer Mathematics would serve a useful purpose in the program. They placed a higher value on algebra than did the high school teachers.

2. The high school teachers seemed to favor the category of business and consumer mathematics as the key topic for the proposed program. They also emphasized the importance of (a) performance of operations on whole numbers, integers, and rational numbers, and (b) arithmetic computation. An assumption here is that the high school teachers felt that consumer-oriented material is a good area where these students would apply their skills with performing operations and computations. They indicated

that number theory, geometry, and measurement should be included as well.

3. There was a degree of agreement between the trades school and the high school teachers particularly concerning Categories A (Performing Operations), C (Arithmetic Computation), F (Geometry), H (Measurement) and J (Business and Consumer Mathematics) where they tended to recommend their inclusion. As well, they both generally were undecided about Category B (Recognizing Properties).

4. Both the high school teachers and the trades school teachers indicated the category of statistics as least in importance for this program. As well, neither group placed much importance on logic or the recognition of properties of number systems.

5. The trades school teachers, more so than the high school teachers, seemed to indicate greater decisiveness relative to what content items they preferred to find in such a mathematics program as described by this study.

6. The aim which the majority of the teachers involved in this study indicated as most important for the proposed program was: To provide a program which will give the students the mathematical concepts necessary to enter the workforce or to enter a trades school to begin studies in courses which the Division of Vocational Education has described as requiring one full year of study.

As observed from the comments of teachers (See Appendix I) there was a variety of opinions as to the teachers feelings of the general direction of such a mathematics program, but there was an indication of discontent with the present offering (i.e. the Basic program). Some directly opposite views were expressed. For instance, a total discontent with the present Grade Ten course was stated as well as the comment that it was the type of course these students should study. The major difference of opinion seemed consistent with the different views on the priority in the aims for the program. As indicated earlier in this report, the high school teachers seemed greatly concerned with providing a consumer-oriented program while the trades school teachers were concerned with arithmetic skills (percents, decimals, fractions). The latter group also expressed a desire to have a general mathematics program which dealt with more algebra than is presently the case, and to include trigonometry, particularly as related to the right triangle.

In summary, a variety of views reflected a variety in the orderings of the aims. Some advocated 'strong' mathematics, some wanted consumer mathematics, and others wanted drill in basic elementary skills. There was not total disagreement between the trades school and the high school teachers, for they tended to agree in their general opinions for about 65 percent of the items listed.

Implications and recommendations

The findings of the study do not indicate total disagreement between the groups of high school teachers and the groups of trades school teachers concerning their perceptions of content items for a general mathematics program. The fact that the trades school teachers were undecided about the question of inclusion of certain items in the program in a fewer number of cases than the high school teachers is not really surprising. Trades school teachers, because of their student population, know what mathematical concepts are necessary and useful as prerequisites for the specific trades for which they must prepare their students. High school teachers, on the other hand, are often caught in the pressures to prepare their students for 'society' and 'everyday' living, for immediate entry into the workforce, and for entry into trades or vocational schools. With society changing so rapidly, with mechanical aids for calculations, and with concern for what mathematics 'everyman' needs and the specifics for trades schools, the high school teachers seemed less decided as to what is necessary for the general program. The two main forces at work seem to be (1) teach the student as much from the discipline of mathematics as he can handle, and (2) teach the student what he needs and will find useful in his everyday living.

As a result of the study, 60 of the 90 content items in the questionnaire are recommended for inclusion in a non-university preparatory mathematics program for the secondary schools of Newfoundland. This suggests that the program be such as to provide a logical and sequential development of the topics from grade to grade. Some of the items here will have been introduced, and at least partially developed, prior to grade 9. Other items will be introduced and at least partially developed in each of the three high school grades. The items which are recommended below for inclusion in a non-university-preparatory program should not be considered as a complete program for grades 9, 10, and 11. A complete program could include other mathematical content as well. It is emphasized, though, that these recommendations are based on the opinions of only two interested groups. Other groups might have vastly different opinions and might wish to add to or delete from items presented here. These other views must be given thorough consideration in formulating any program. However, the views presented here could serve as useful information as wlll.

In order for any of the original 90 content items involved in the study to be on the list recommended for inclusion in this non-university preparatory program, it had to satisfy one of the following conditions:

1. It was recommended for inclusion in the program by the group of high school teachers and by the group of

trades school teachers (i.e. by the groups HST and TST).

2. It was recommended for inclusion in the program by the group of high school teachers while the group of trades school teachers was undecided about its inclusion.

3. It was recommended for inclusion in the program by the group of trades school teachers while the group of high school teachers was undecided about its inclusion.

The following is a list of content items recommended to be included in a general mathematics program and selected according to the above criteria.

A. Performing operations (addition, subtraction, multiplication, and division) on the following number system:

1. Whole numbers.
2. Integers.
3. Rational numbers.

B. Arithmetic computation.

4. Computation involving ratio and proportion.
5. Computing with percent.
6. Rounding-off numbers.
7. Converting from one mode of numeral to others (eg. from decimal form to fractional form).
8. Solving problems using direct variation.

C. Number Theory

9. Finding the G.C.F. for two whole numbers.
10. Finding the L.C.M. for two whole numbers.

11. Writing prime factorization for natural numbers.

12. Writing numerals in scientific notation.

D. <u>Algebra</u>

13. Knowing the language of algebra (eg. polynomial, variable).

14. Adding and subtracting non-fractional algebraic expressions (i.e. combining like terms).

15. Adding and subtracting polynomials in one variable,

16. Knowing and applying laws of exponents ($a^m \cdot a^n = a^{m+n}$; $a^m \div a^n$ a^{m-n}; $(a^m)^n = a^{mn}$).

17. Multiply polynomials (monomials, binomials, trinomials) in one variable.

18. Solving linear equations of the type $ax + b = c$, where $a, b, c \in I$.

19. Solving linear equations of the type $ax + b = cx + d$, where $a, b, c, d \in I$.

20. Solving word problems using linear equations in one variable.

21. Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, by using tables of values.

22. Graphing linear equations of the type $y = ax + b$, where $a, b, \in I$, by the slope-intercept method.

23. Solving systems of linear equations in two variables by the substitution and/or addition method.

E. Geometry

24. Studying some basic concepts of geometry. (eg. point, line, plane, ray, angle).

25. Defining and applying types of lines (parallel, intersecting, perpendicular).

26. Naming and identifying properties of simple plane figures.

27. Performing basic constructions using ruler, pencil, and compass.

28. Stating and applying the Pythagorean Theorem.

29. Identifying and defining different types of triangles.

30. Identifying and defining different types of angles.

31. Identifying and naming the parts of a circle.

32. Applying formulas for finding area and perimeter of common plane figures.

33. Identifying congruent triangles by the SSS, SAS, and ASA conditions.

34. Applying properties of similar triangles to solve problems.

35. Applying the Distance Formula.

F. Trigonometry

36. Defining basic trigonometric ratios relative to the right triangle.

37. Knowing the relationships among these basic

trigonometric ratios.

38. Solving right triangles using the basic trigonometric ratios.

39. Solving applied problems using the basic trigonometric ratios as related to the right triangle.

G. Measurement

40. Finding and computing with linear measure.

41. Finding square measure as in the area of common plane figures and solids.

42. Finding cubic measure as in the volume of rectangular solids.

43. Finding and computing with angular measure.

44. Finding measure indirectly by using similar triangles and proportions.

45. Finding units of precision and greatest possible error with measurement.

46. Finding relative error and percent of error with measurements.

H. Business and consumer mathematics.

47. Preparing and working on budgets.

48. Solving problems dealing with installment buying.

49. Solving problems dealing with buying a car.

50. Solving problems dealing with buying a home.

51. Solving problems dealing with borrowing money.

52. Solving problems dealing with insurance (life, fire, car, and home).

53. Solving problems dealing with personal bank records.

54. Solving problems dealing with sales and income taxes.

55. Solving problems dealing with personal earnings.

56. Making intelligent use of mechanical aids to computation.

I. Logic

57. Putting together a logical argument.

58. Using deductive reasoning.

59. Making a flow-chart organization for problem solving.

60. Determining the validity of an argument.

It might also be noted that the opinions of the respondents in this study may be biased to reflect their personal views. For instance, the group TST_{213} may have been considering mathematics as related to specific trades with whom they, as teachers, have had contact. This is not to say, however, that their views are invalid or to be overlooked, but that any recommendations resulting from teacher opinion - as from any group's opinion - should be viewed with proper discretion.

Some of the items recommended for exclusion from the program by teachers involved in this study are considered by some educators as basic skills. One such area deals with statistics. Skills which are basic today may have had very little utility role to play a decade ago. Similarly, skills considered by many today as unnecessary may be basic in the society of the 1990's. Teachers have to do some serious thinking as to what is really basic in today's society and what will be basic a decade hence. Consequently, it is recommended that other research be done to study the views of instructors from high schools, trades schools, universities and other post-secondary institutions as well as from the business and trade world in order to determine other relevant material for a non-university preparatory mathematics program.

A final recommendation is that the curriculum decision makers for Newfoundland secondary schools give due consideration to the results of this and other studies designed to provide worthwhile input into the formulation of appropriate programs for the students of this province.

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Appendix A

The Rationale for the Tri-Level Program in the High Schools of Newfoundland

Appendix A: The rationale for the Tri-level Program in the high schools for Newfoundland.

General objectives of Matriculation Mathematics Program:

1. To offer a mathematics program in which essential mathematics concepts and skills are adequately presented utilizing a practical approach, with emphasis on applications and practice rather than emphasis on involved mathematical structure and terminology.

2. To provide a mathematics program which will enable students to acquire knowledge and essential concepts and skills needed for further educational pursuits, commercial, economic and social endeavours in the life area of their choice.

General objectives of the Honours Mathematics Program:

1. To provide a more challenging program for the mathematically gifted student.

2. To provide a program which emphasizes the developmental and structural components of mathematics.

3. To provide recognition of the historical milestones in the development of mathematical ideas - ideas which have helped man in solving many of his problems.

4. To provide awareness of the direct application of mathematics to behavioral, social and applied sciences.

General objectives of the Basic Mathematics Program:

1. To provide a program which emphasizes the practical, social and computational aspects of Mathematics.

2. To provide a program which emcompasses constant review and practice with computational skills, mathematics of everyday living, some 'trades' oriented mathematics, and some mathematics of business.

3. At grades seven and eight - to provide a remedial program which will enable students who have become severely handicapped mathematically the opportunity to improve on basic skills necessary to achieve success at higher levels.

4. At Senior High School level - to provide a program which will expose students to mathematical concepts which will enable them to enter the workforce or some 'trades' oriented program immediately on leaving the educational system.

Appendix B

What is 'Really' Wanted as a Minimum
Residue for Everyman from the
School Mathematics Experience
(Max Bell)

Appendix B: A short tentative list of what is 'really' wanted as a minimum residue for everyman from the school mathematics experience. Reprinted from the Mathematics Teacher, March, 1974.

1. The main uses of numbers (without calculation).	1.1 Counting 1.2 Measuring 1.3 Coordinate systems 1.4 Ordering 1.5 Indexing 1.6 Identification numbers, codes 1.7 Ratios
2. Efficient and informed use of computation algorithms.	2.1 Intelligent use of mechanical aids to calculation
3. Relations such as equal, equivalent, less or greater, congruent, similar, parallel, perpendicular, subset, etc.	3.1 Existence of many equivalence classes 3.2 Flexible selection and use of appropriate elements from equivalence classes (eg. for fractions, equation, etc.)
4. Fundamental measure concepts.	4.1 "Measure functions" as a unifying concept 4.2 Practical problems; role of "unit"; instrumentation; closeness of approximation. 4.3 Pervasive role of measures in applications 4.4 Derived measures via formulas and other mathematical models.
5. Confident, ready and informed use of estimates and approximations	5.1 "Number sense" 5.2 Rapid and accurate calculation with one and two digit numbers 5.3 Order of magnitude 5.4 Guess and verify procedures; recursive processes 5.5 Appropriate calculation via positive and negative powers of ten 5.6 "Measure sense" 5.7 Use of appropriate ratios 5.8 Rules of Thumb; rough conversions (eg. "a pint is a pound") standard modules

	5.9 Awareness of reasonable cost of amount in a variety of situations.
6. Links between "the world of mathematics" and "the world of reality"	6.1 Via building and using "mathematical models" 6.2 Via concrete "embodiments" of mathematical ideas
7. Uses of variables	7.1 In formulas 7.2 In equations 7.3 In functions 7.4 For stating axioms and properties 7.5 As parameters
8. Corespondences, mappings, functions, and transformations	8.1 Inputs, outputs, appropriateness of these for a given situation 8.2 Composition ("If this happens and then that, what is combined reality?") 8.3 Use of representational and coordinate graphs
9. Basic logic	9.1 "Starting points": agreements (axioms) and primitive (undefined) words 9.2 Consequences of altering axioms (rules) 9.3 Arbitratiness of definitions; need for precise definition 9.4 Quantifiers (all, some, etc) 9.5 Putting together a logical argument
10. "Chance" fundamental probability ideas, descriptive statistics	10.1 Prediction of mass behavior vs. unpredictability of single events 10.2 Representative sampling from populations 10.3 Descriptive via arithmetic average, median, standard deviation
11. Geometric relations in plane and space	11.1 Visual sensitivity 11.2 Standard geometry properties and their application 11.3 Projections from three to two dimensions

12. Interpretation of informational graphs	12.1 Appropriate scales, labels, etc. 12.2 Alertness to misleading messages
13. Computer uses	13.1 Capabilities and limitations 13.2 "Flow chart" organizations of problems for communication with computer

Appendix C

Some 'Big Ideas' in the Liberal-Arts Approach to Mathematics

(I.A. Dodes)

Appendix C: Some 'big ideas' in the liberal-arts approach to Mathematics. Reprinted from The Mathematics Teacher, March, 1967.

1. Mathematicians: who, what, when, why?

Bhaskara was a great mathematician for his times, but in some respects he did not show much common sense. Explain.

2. The basic nature and laws of numbers.

a) Use the distributive principle to find 8 x 999.

b) Decide whether the uses of the numbers in following are exact or approximate: (1) 1 weight 120 pounds. (2) There are 5,280 feet in 1 mile.

3. Illustrations of mathematics in science and technology.

a) Find the wattage of a TV set that takes 112 volts and draws 14.2 amperes. (Formula given).

b) What is the SAE horsepower of a 6-cylinder car with cylinders of 3.25 inch diameter? (Formula given).

4. Interpretation of graphs

a) Given a sketch of a flower, "code" it in terms of coordinates.

b) Given a statistical graph, interpret it.

c) Given a time-change graph, interpolate and extrapolate.

d) Draw a graph for $y = 2x - 1$.

5. Making and solving formulas and open sentences.

a) Translate into English: $3x + 8 = 2x + 10$.

b) The sum of five consecutive odd numbers is 30, Find the numbers.

c) Graph a set of simulaneous relations.

d) Given a set of coordinates, find the "visual line of best fit".

6. Experimental techniques: sampling, inference

a) The producer of a television show wanted to measure its popularity. He called 25 people in various occupations: one teacher, one doctor, one plumber, one housewife, and so on. He collected their opinions and draw conclusions. Discuss.

b) A food product advertises a butter fact content of 4.0. Tests on a sample show 3.8, 4.0, 4.2, 3.8. Discuss the validity of the claim.

7. Experimental geometry, including simple focus.

a) (Map given) A manufacturer wishes to establish a factory equidistant from Elephant Creek and Fox Creek, and also equidistant from Indian City and Jeremoiah City.

Where should the factory be located?

b) Draw any triangle ABC. Find the midpoint of AB. Call this M. Through M, draw a line parallel to BC, cutting AC at N. Compare MN and BC, also AN and NC. (In the book the diagram is given.)

8. Indirect measurement

(Using a home-made "transit") Measure the width of your classroom, and check by direct measurement.

9. Logic

a) Point out the word or words that need a definition: Mrs. Rich said, "This hat is not expensive".

b) Dicsuss: In an argument about doing the dishes, Leon said to Alice, "You should do the dishes, Alice. After all, you're a girl".

c) Draw a diagram for: If X is a skree, then X is a zilch.

d) Discuss: Every good baseball player must have good muscular coordination. John has excellent muscular coordination. He should be a good ball player.

e) Discuss: A safety device was put on this machine a year ago. It was a waste of time, because we have not had an accident since it was put on.

f) Discuss: Lyons is in France, and Paris is in France. Therefore, Paris is in Lyons.

10. Topics associated with simple set theory, eg., probability.

a) A questionnaire study showed that 19 people liked Brand A, 18 liked Brand B, and 20 liked Brand C. Five of these people liked A and B, 8 liked B and C, and 7 liked A and C. Two liked all three. How many people were there? (Done by diagram).

b) Mary has been told that she must take pills for an illness. In each month, she needs at least 20 units of X but not more than 50 units. She needs 10 units of Y but not more than 40 units. She should have at least 40 units of X and Y together. If X costs $1.00 per unit and Y costs $2.00 per unit, what is the cheapest satisfactory combination? (Done graphically).

Appendix D

Possible Topics for the Mathematics Program for Low Achievers in Junior High School

(S. Weiss)

Appendix D. A study by Weiss of possible topics for the mathematics program for low achievers in junior high school. Reprinted from The Mathematics Teacher, November, 1969.

Topics	No(%)	Yes(%)	Index	Recommendation
Whole and Rational Numbers				
1. Operations	1.3	97.4	4.9	Yes
2. Properties	3.9	88.4	4.6	Yes
3. Negative rational numbers	11.6	77.4	4.2	Yes
Real Numbers				
4. Operations	20.0	65.2	3.9	Yes
5. Properties	25.8	52.9	3.5	Yes
6. Systems of numeration (bases other than ten)	15.8	58.7	3.8	Yes
7. Sets	18.1	58.1	3.8	Yes
8. Ratio and percent	3.9	89.0	4.6	Yes
Number Theory				
9. Primes	7.7	74.2	4.3	Yes
10. Divisibility	11.0	71.0	4.1	Yes
11. Highest common factor	12.3	68.4	4.0	Yes
12. Lowest common multiple	12.3	71.0	4.1	Yes
13. Clock arithmetic	20.6	53.5	3.6	Yes
14. Nonmetric geometry	12.3	53.2	4.0	Yes
Instuitive Geometry				
15. Congruence	5.8	81.9	4.4	Yes
16. Similarity	3.9	81.9	4.4	Yes
17. Basic constructions	6.5	81.9	4.4	Yes
18. Symmetry	7.1	68.4	4.1	Yes
19. Trigonometric ratios	36.8	35.5	3.0	Undecided
Measurement				
20. Linear	0.6	95.5	4.8	Yes
21. Square	0.6	94.8	4.8	Yes
22. Cubic	1.3	89.0	4.7	Yes
23. Pythagorean theorem	4.5	78.7	4.3	Yes
24. Formulas	3.2	85.2	4.5	Yes
25. Equations	3.2	90.3	4.5	Yes
26. Inequalities	11.0	63.2	3.9	Yes
27. Graphs and statistics	5.2	81.9	4.3	Yes
28. Permutations and combinations	42.6	27.1	2.7	Undecided
29. Probability	33.5	49.0	3.2	Undecided
30. Vectors	59.4	18.7	2.2	No
31. Coordinate geometry	34.8	43.2	3.0	Undecided
32. Linear programming	64.5	11.0	1.9	No

Topics	No(%)	Yes(%)	Index	Recommendation
Logic				
33. Proof	49.0	29.7	2.6	Undecided
34. Deductive reasoning	41.9	37.4	2.9	Undecided
35. Truth tables	59.4	15.5	2.2	No
36. History of mathematics	23.2	51.6	3.5	Yes
37. Slide rule	29.0	42.6	3.2	Undecided
38. Computer mathematics	40.6	24.5	2.6	Undecided
39. Computing earnings	29.7	45.8	3.2	Undecided
40. Handling money and accounts	22.6	61.9	3.7	Yes
Managing Income				
41. Budgets	32.3	43.2	3.2	Undecided
42. Installment buying	29.7	42.6	3.3	Undecided
43. Buying a home	40.6	29.7	2.8	Undecided
44. Buying a car	32.3	40.6	3.2	Undecided
45. Insurance	37.4	36.8	3.0	Undecided
46. Taxation	37.4	38.1	3.0	Undecided
47. Measuring instruments and devices (How to read and use)	5.8	67.7	4.3	Yes

Appendix E

Topics which are Good Vehicles for
Developing Understanding of
Mathematical Concepts
(J. D. Wilson)

Appendix E: A few topics suggested by Wilson as good vehicles for developing of understanding of mathematical concepts. Reprinted from The Mathematics Teacher, November, 1960.

1. Numeral systems: The study of numeral systems with bases other than ten helps to develop a broader understanding of our system.

2. Structure of our algebraic systems: An attempt must be made to give the terminal student some idea as to the nature and structure of algebraic systems. This should help to clarify the student's understanding of the number systems that he meets in ordinary life: the whole numbers, the integers, the rationals and the reals.

3. Elements of statistics: All our students should have some instruction in elementary statistics but again the development of concepts must occupy a central position.

4. Elements of algebra: The elements of algebra should be presented and developed to whatever degree is feasible in a given classroom. Various practical applications involving formulas and ratios will provide a link with life situations. A culminating activity might be the development and utilization of the constant ratio formula for computing interest rates in installment buying.

5. Review of basic fundamentals: In courses for terminal students we must arrange for interesting drill exercises as well as diagnostic and remedial instruction and straightforward basic drill.

Appendix F

Minimum 'Doing' Skills that every Enlightened Citizen Should Possess

(Edwards et al)

Appendix F: A list of minimum 'doing skills that every enlightened citizen should possess. Reprinted from the Mathematics Teacher, November, 1972.

1. Numbers and numerals
   (a) Express a rational number using decimal notation.
   (b) List the first ten multiples of 1 through 12.
   (c) Use the whole numbers in problem solving.
   (d) Recognize the digit, its place value and the number represented through billions.
   (e) Describe a given positive rational number using decimal, percent, or fractional notation.
   (f) Convert to Roman numerals from decimal numerals and conversely (eg. date translation).
   (g) Represent very large and small numbers using scientific notation.

2. Operations and properties
   (a) Write equivalent fractions for given fractions such as $\frac{1}{2}$, $\frac{1}{4}$.
   (b) Use the standard algorithms for operations of arithmetic of positive rational numbers.
   (c) Recognize and use properties of operations (grouping, order, etc.) and properties of certain numbers with respect to operations ($a \cdot 1 = a$; $a + 0 = a$, etc.)
   (d) Solve addition, subtraction, multiplication, and division problem involving fractions.
   (e) Solve problems involving percent.
   (f) Perform arithmetic operations with measures.
   (g) Estimate results.
   (h) Judge the reasonableness of answers of computational problems.

3. Mathematical sentences
   (a) Construct a mathematical sentence from a given verbal problem.
   (b) Solve linear equations such as $a + 3 = 12$ and $4a - 2 = 18$.
   (c) Translate mathematical sentences into verbal problems.

4. Geometry
   (a) Recognize horizontal, parallel, vertical, perpendicular, and intersecting lines.
   (b) Classify simple plane figures by recognizing their properties.
   (c) Compute perimeters of polygons.
   (d) Compute the areas of rectangles, triangles and circles.
   (e) Be familiar with concepts of similarity and congruency of triangles.

5. Measurement
   (a) Apply measures of length, area, volume (dry or liquid)

weight, time, money, and temperature.
(b) Use units of length, area, mass, and volume in making measurements.
(c) Use standard measuring devices to measure length, area, volume, time, and temperature.
(d) Round off measurements to the nearest given unit of the measuring device (ruler, protractor, etc.) used.
(e) Read maps and estimate distances between locations.

6. Relations and functions
   (a) Interpret information from a graphical representation of a function.
   (b) Apply the concepts of ratio and proportions to construct scale drawings and to determine percent and other relations.
   (c) Write simple sentences showing the relations $>$, $<$, $=$, and $\neq$ for two given numbers.

7. Probability and statistics
   (a) Determine mean, median, and mode for given numerical data.
   (b) Analyze and solve simple probability problems such as tossing coins or drawing one red marble from a set containing one red and four while marbles.
   (c) Estimate answers to computational problems.
   (d) Recognize the techniques used in making predictions and estimates from samples.

8. Graphing
   (a) Determine measures of real objects from scale drawings.
   (b) Construct scale drawings of simple objects.
   (c) Construct graphs indicating relationships of two variables from given sets of data.
   (d) Interpret information from graphs and tables.

9. Mathematical reasoning
   (a) Produce counterexamples to test the validity of statements.
   (b) Detect and describe flaws and fallacies in advertising and propaganda where statistical data and inferences are employed.
   (c) Gather and present data to support an inference or argument.

10. Business and consumer mathematics
   (a) Maintain personal bank records.
   (b) Plan a budget including record keeping of personal expenses.
   (c) Apply simple interest formulas to installment buying.
   (d) Estimate the real cost of an object.
   (e) Compute tax and investment returns.
   (f) Use the necessary mathematical skills to appraise insurance and retirement benefits.

Appendix G

A Mathematics Program in Baltimore High Schools

(W. J. Gerardi)

Appendix G: A mathematics program offerred in Baltimore high schools, 1965. Reprinted from the Catholic School Journal, December, 1965.

Grade	Classes Per Week	Topics
9	5	Equations and formulas; directed numbers; graphic representation; constructions; right triangle; ratio and proportions; indirect measurement; applications of percent.
10	5	Earning money; budgeting; buying wisely; installment buying; home and job mathematics; taxation; insurance; banking; investment.
11	4	Number systems; numbers and operations; numbers in measurement; rational numbers; numbers in percent; angles and polygons; equations; perimeters and areas; surfaces and volumes; ratio and proportions; indirect measurement; financial transactions.
12	3	Slide rule; computer mathematics; personal finance; buying and owning an automobile; buying a home; income tax; industrial and business applications; social security and insurance; statistics; probability.

Appendix H

Comments of Trades School Teachers

Appendix H: Excerpts from the comments of trades school teachers.

1. There is a need for such a non-academic program that our present general programs do not seem to be filling.

2. On the basis of my three years' experience in vocational education, I find that the majority of the students I deal with ... have little practical ability to use basic mathematical concepts. I am in full agreement that there must be a non-university courses in which students can learn the basic concepts that will enable them to function efficiently in either the workforce or vocational education system.

3. I am not sure there is a need. There are many courses offerred now to give the students a better background in mathematics - BTSD, high school night courses, etc. These programs are oriented for the trades. All are also of a general nature. Many of the programs are becoming more and more individualized.

4. I believe that it will be difficult to motivate students to do this sort of a program. It seems that the non-university preparatory students, for the most part, do not want to do mathematics of any kind until shown, in their own trade, the need for it.

5. Students do not have a good grasp of the fundamentals of mathematics (eg. fractions, decimals, percents, square roots). Problem solving and persistency in problem solving are definitely weak.

6. Any course involving the non-academic students at the grades 9, 10, and 11 level should involve at least one period per week on problem-solving ... At the present time 90% of the students in my math classes are terrified of problems involving mathematics and they assure me that they get very little practice in problem-solving at school.

7. Many students are no longer interested in attending university; thus, it is only rational that we give them a better selection than they now have ... It seems to this point that this country has trained many of its people theory-wise but omitted the practical aspects.

8. In my opinion, a good drill in a few of (the stated items in the questionnaire) is essential and preferable over touching everything we can think of. There is certainly a need for a program you are working on. (It) will certainly uplift those adults and dropouts who, because of one reason or the other, could not continue their education.

9. There is a definite need for a program of this type. During the past few years we have noted that each new 'crop' of students is progressively worse with computational skills ... All we require is that they know how to add, subtract, multiply, divide rational numbers; interconvert decimals, percents, and fractions; solve simple equations. The rest we can do as we teach the applications.

10. Students are extremely weak in basics ... We

(trades school teachers) should be concentrating on trade applications instead of having to spend a lot of time on basics .... In most cases I find the high school graduates of several years ago is better than a recent graduate.

Appendix I

Comments of High School Teachers

Appendix I: Excerpts from the comments of high school teachers.

1. I feel that the most neglected area of the whole curriculum is the 'general' mathematics program ... Topics are not related progressively from grade to grade – there is no structure in the entire high school program.... The total emphasis by the leaders or decision makers in education seems to be on the university bound students. A prime example is the "methods" courses at MUN (Ed. 4160/4161). There was absolutely no mention of the general student or the general program.

2. A general program ... is one that the students who cannot cope with the regular program must take ... Consumerism and everyday practical application of simple mathematical concepts should be the core of the program.

3. I feel that the non-matriculation mathematics program at the Grade Ten level is practically useless.

4. There is a great need for such a program which should have many examples of each item.

5. I feel that the chief aim of a non-university preparatory program has to concern itself with preparing students for everyday living. No doubt, much of what they learn will be an asset for trade purposes, but I feel the program should be prepared for students who will finish his mathematics at high school.

6. (The) Basic mathematics student of my experience has had the ability to cope with matriculation mathematics

and would have coped if aim (a) above had been our objective. The only reason the student found himself on the Basic mathematics program is due to the lack of background, rather than personal choice. So, while there should be a sound non-university preparatory mathematics program with (a) and (c) as the prime objectives, perhaps our schools should have a third program with aim (a) as the number one objective.

7. I do not think the non-academic program should involve material pertaining to specific trades. Rather, the material should be broad and practical, thus preparing the non-academic student for many fields of further training.

8. Your questions are still geared too much toward an academic program.

9. (A) lot of the algebra and the geometry now learned will be of no use to them in the future ... Also a large percentage of our students cannot cope with the geometry and algebra and need some course which will be more valuable to them as they enter the workforce.

10. I feel that the present Basic Mathematics II is inadequate for serving the needs of students leaving high school.

11. Students should only be allowed in such a course after demonstrating that they are totally inadequate in a matriculation program.

12. I find it disheartening to see inadequate programs made compulsory for these (general) students. The mathematics is either too simple, non-interesting, or not relevant for the most part.

13. The present program now being used for the non-university bound students is not suitable; therefore (we need) any program which would improve on it with emphasis on aim (b).

14. There are far too many students on the Basic program as it is today. We need such a program but it has to be stronger mathematics and a better approach than at present. The present program does not prepare students for any form of post-secondary education.

15. The present programs were no doubt designed to meet these aims, but they fail to do so.

16. What are you searching for - a non-academic program for intelligent, hard-working students or an excuse for a mathematics program for the lazy and/or non-intelligent students? We may need the former; the latter we have now ... I have found quite often while teaching non-academic students that they are of two types: the academically lazy and the below average. Those who are lazy get worse as they are faced with easier work, and we keep lowering standards to accommodate them ... Any student who cannot get through our present Matriculation program is not deserving of a high school diploma in mathematics. Our Basic pro-

gram is an insult to anyone intelligent.

17. I feel that a mathematics course such as proposed is needed and should include mathematical concepts which would prepare the student to be a knowledgeable consumer.

18. I feel the program should be a mathematics course - not an economics course as the present Basic X tends to be.

19. There is one course that now partially fulfils some of the objectives that I perceive should be in a non-university preparatory program, namely, Consumer Related Mathematics, Grade X.

20. I feel that such a program should be placed between the Basic and the Matriculation course as they now stand.

Appendix J.

A Letter Sent to High School Teachers

Appendix J: The letter, accompanying each questionnaire, sent to the high school teachers.

P. O. Box 528
Clarenville, Nfld.
AOE 1JO
May 5, 1978

Dear Mathematics Educator:

I would appreciate your completing the enclosed questionnaire to help me complete my theses for a Masters of Education degree. The questionnaire contains 45 items randomly selected from a larger list. I trust that you will assist me in this, the last stage of my study.

From this study I hope to establish a recommended list of content items for a non-university preparatory mathematics program for grades 9 - 11. I would appreciate it if you would complete the following data sheet and questionnaire. It is not necessary for you to provide your name.

Please consider each item on the questionnaire from the viewpoint that the student should reach an acceptable level of proficiency in that particular topic; that is, each topic is a core topic. This is not to suggest the grade level in which any topic is to be covered. Please indicate your choice concerning the inclusion of the given content items in this program.

As a classroom teacher, I am acutely aware of the busy time of year at hand. Nevertheless, I trust that you will take the necessary time to complete the questionnaire and forward it to me within two weeks. In anticipation of your cooperation, I sincerely thank you. At your request, I will forward you the results and recommendations of this study upon its completion.

I wish you continued success with your work and a good, refreshing summer vacation.

Yours truly,

Warren Cole

Appendix K

A Letter Sent to Trades School Teachers

Appendix K: The letter, accompanying each questionnaire, forwarded to the trades school teachers.

P. O. Box 528
Clarenville, Nfld.
AOE 1JO
May 5, 1978

Dear Mathematics Educator:

I would appreciate your completing the enclosed questionnaire to help me complete my thesis for a Masters of Education degree. My total study population included teachers of mathematics from high schools and trades schools. My questionnaire is in two forms, each of which contains 45 items, randomly selected from a larger list. Since the number of trades school teachers is much smaller than the number of high school teachers, I am asking you to please complete both of the forms. There is no repetition of any content items.

From this study I hope to establish a recommended list of content items for a non-university preparatory mathematics program for grades 9 - 11. I would appreciate your completing the following data sheet and questionnaires. It is not necessary for you to provide your name.

Please consider each item on the questionnaire from the viewpoint that the student should reach an acceptable level of proficiency in that topic; that is, it is to be a core topic. This is not to suggest the grade level at which any topic is to be covered. Please indicate your choice concerning the inclusion of the content items in the program.

As a classroom teacher I am acutely aware of the busy time of year at hand. Nevertheless, I trust that you will take the necessary time to complete the questionnaire and to return it to me within two weeks. At your request I will forward to you the results and recommendations of this study upon its completion.

In anticipation of your cooperation, I sincerely thank you. I wish you continued success with your work and a good, refreshing summer vacation.

Yours truly,

Warren Cole

Appendix L

Follow-up Letter

Appendix L: The follow-up letter forwarded to the Principal or Mathematics Department Head of the schools from which the replies seemed a little slow in coming.

P. O. Box 528
Clarenville, Nfld.
AOE 1J0
May 15, 1978

Dear Principal or Math. Dept. Head:

Approximately two weeks ago I had sent you some questionnaires relating to a study that I am doing for my Masters of Education degree and had asked you to pass them along to your Mathematics teachers to complete and return them. If you have already done this I now thank you.

If you have not, or if your teachers have not yet returned their replies, I would greatly appreciate your encouraging your teachers to do so. Without your assistance my study cannot be a success.

Once again, your cooperation in this matter will be very much appreciated by me.

Yours truly,

Warren Cole

Appendix M

The Data Sheet

Appendix M: The data sheet completed by the respondents.

PLEASE COMPLETE THE FOLLOWING DATA SHEET

At which of the following do you presently teach:

1. a high school 2. a trades school? ________________

For how many years have you been teaching? ________________

For how many years have you taught non-university preparatory (i.e. non-academic) high school mathematics courses? ________________.

What university degree(s) do you have? ________________

When did you receive your last degree? ________________

When did you complete your last study of a university course? ________________

What teaching grade (i.e. certificate or equivalent) do you hold? ________________

What is your age? ________________

How many university Mathematics courses have you completed? ________________. (A course being equivalent to a university's semester course).

The following are possible aims of a non-university preparatory mathematics program for grades 9, 10, and 11, which is the concern of this study. Would you please rank them from 1 to 3 to indicate your perception of the importance of these aims for such a program? (A rank of 1 indicates that you give the aim top priority for the program, while a rank of 3 indicates third position in importance.)

Rank ____ (a) Everyday living: To provide a program which emphasizes the practical, social and computational skills which are necessary for everyday living.

Rank ____ (b) Vocational: To provide a program which will give the students the mathematical concepts necessary to enter the workforce, or to begin studies at a vocational or trades school in courses which the Department of Vocational Education has described as requiring one full year of study.

Rank ____ (c) Remedial: To provide a program which will offer remedial work to students who have experienced difficulties with mathematics and will give them the opportunity to experience success and to return to an academic program (i.e. the present Matriculation program or its equivalent).

Appendix N

Questionnaire - Form A

Appendix N: Questionnaire Form A

Bearing in mind your ranking of the three aims of proposed non-university preparatory mathematics program, please circle the number in the 'Rating' column which best indicates your opinion relative to the inclusion of the following content items into this program for Newfoundland high schools. The rating scale is given below:

1 definitely should be included in the program

2 probably should be included in the program

3 undecided

4 doubt that it should be included in the program

5 definitely should not be included in the program

CONTENT ITEMS	RATING				
1. Computation involving ratio and proportion	1	2	3	4	5
2. Finding measures indirectly by using similar triangles and proportions	1	2	3	4	5
3. Solving problems dealing with insurance (car, home, fire, life)	1	2	3	4	5
4. Stating and applying Pythagorean Theorem	1	2	3	4	5
5. Applying the properties of similar traingles to solve problems	1	2	3	4	5
6. Recognizing properties (commutative, associative, identities, inverses) of irrational numbers.	1	2	3	4	5
7. Defining the basic trigonometric ratios, using the right triangle.	1	2	3	4	5
8. Solving applied problems using the trigonometric ratios relative to the right triangle.	1	2	3	4	5
9. Defining and naming subsets of a given set	1	2	3	4	5
10. Finding absolute value of rational numbers	1	2	3	4	5
11. Solving problems using direct variation	1	2	3	4	5
12. Proving a simple theorem	1	2	3	4	5
13. Solving problems dealing with personal earnings.	1	2	3	4	5

CONTENT ITEMS	RATING				
14. Finding the greatest common factor of two whole numbers.	1	2	3	4	5
15. Performing operations (addition, subtraction, multiplication, division) on rational numbers.	1	2	3	4	5
16. Solving linear inequalities of the type $ax + b > c$, where $a, b, c \in I$. (eg. $4x + 3 > 15$)	1	2	3	4	5
17. Finding square measures as in the area of common plane figures and solids	1	2	3	4	5
18. Making intelligent use of mechanical aids to calculation.	1	2	3	4	5
19. Solving problems dealing with buying a car.	1	2	3	4	5
20. Probability (concept of randomness, approaches to probability).	1	2	3	4	5
21. Defining and applying tupes of lines (parallel, intersecting, perpendicular)	1	2	3	4	5
22. Multiplying polynomials (monomials, binomials, trinomials) in one variable	1	2	3	4	5
23. Graphing quadratic equations of the type $y = ax^2 + bx + c$, where $a, b, c \in I$. (eg. $y = 3x^2 + x + 1$)	1	2	3	4	5
24. Recognizing a function from given sets of ordered pairs of numbers.	1	2	3	4	5
25. Performing basic constructions using ruler, pencil, and compass	1	2	3	4	5
26. Finding and computing with linear measure	1	2	3	4	5
27. Solving linear equations of the type $ax + b = cx + d$, where $a, b, c, d \in I$.	1	2	3	4	5
28. Defining the basic trigonometric ratios, using the unit circle.	1	2	3	4	5
29. Performing operations (addition, subtraction, multiplication, division) on whole numbers.	1	2	3	4	5
30. Factoring polynomials of the type $x^2 + bx + c$, where $b, c \in I$. (eg. $x^2 + 5x + 6$)	1	2	3	4	5
31. Naming the union and intersection of sets	1	2	3	4	5
32. Converting from one mode to another (eg. from fractional form to decimal form).	1	2	3	4	5

CONTENT ITEMS	RATING
33. Applying the Distance Formula.	1 2 3 4 5
34. Writing numerals in scientific notation	1 2 3 4 5
35. Solving quadratic equations of the type $ax^2 + bx + c = 0$, where $a, b, c \in I$, by using the Quadratic Formula, (Eg. $2x^2 + x - 4 = 0$.)	1 2 3 4 5
36. Solving problems dealing with personal bank records.	1 2 3 4 5
37. Calculating percentiles in statistical data.	1 2 3 4 5
38. Dividing polynomials having one variable	1 2 3 4 5
39. Finding measures of central tendancy (mean, mode, median, skewness).	1 2 3 4 5
40. Finding and computing with angular measure.	1 2 3 4 5
41. Putting together a logical argument.	1 2 3 4 5
42. Solving a system of equations in two variables by the substitution and/or addition method.	1 2 3 4 5
43. Defining and identifying different types of angles.	1 2 3 4 5
44. Studying the history of mathematics	1 2 3 4 5
45. Writing prime factorization of natural numbers.	1 2 3 4 5

PLEASE COMPLETE THE FOLLOWING

(a) If you feel that such a program as proposed here should meet an aim not mentioned, would you please state that aim?

(b) In a few words, would you please state your general feelings concerning the need for such a non-university preparatory program with the aims stated earlier to be placed in Newfoundland high schools.

Appendix O

Questionnaire - Form B

Appendix O: Questionnaire Form B

Bearing in mind your ranking of the three aims of the proposed non-university preparatory mathematics program, please circle the number in the 'Rating' column which best indicates your opinion relative to the inclusion of the following content items into this program for Newfoundland high schools. The rating scale is given below:

1 definitely should be included in the program

2 probably should be included in the program

3 undecided

4 doubt that it should be included in the program

5 definitely should not be included in the program

CONTENT ITEMS	RATING
1. Identifying congruent triangles by the SSS, SAS, and ASA conditions.	1 2 3 4 5
2. Preparing and working budgets	1 2 3 4 5
3. Defining and identifying different types of triangles.	1 2 3 4 5
4. Adding and subtracting non-fractional algebraic expressions (i.e. combining like terms).	1 2 3 4 5
5. Using deductive reasoning	1 2 3 4 5
6. Calculating measures of dispersion (eg. range, variance, standard deviation)	1 2 3 4 5
7. Using instruments to make readings for indirect measure (eg. a transit).	1 2 3 4 5
8. Naming and identifying properties of simple plane figures.	1 2 3 4 5
9. Solving linear equations of the type $ax + b = c$, where $a, b, c \in I$ (eg. $3x + 2 = 8$)	1 2 3 4 5
10. Solving problems dealing with borrowing money.	1 2 3 4 5
11. Determining the validity of an argument.	1 2 3 4 5
12. Performing operations (addition, subtraction, multiplication, division) on integers.	1 2 3 4 5
13. Solving problems dealing with sales and income taxes.	1 2 3 4 5

CONTENT ITEMS	RATING
14. Applying formulas for finding perimeter and area of common plane figures (eg. Triangles).	1 2 3 4 5
15. Graphing linear equations of the type $y = ax + b$, where $a, b, \in I$ (eg. $y = 2x + 1$) using tables of values	1 2 3 4 5
16. Graphing linear equations of the type $y = ax + b$, where $a, b \in I$, by the slope-intercept method.	1 2 3 4 5
17. Recognizing properties (commutative, associative, distributive, inverse, identities) of whole numbers.	1 2 3 4 5
18. Finding relative error and percent of error in measurement.	1 2 3 4 5
19. Defining and identifying parts of the circle.	1 2 3 4 5
20. Recognizing properties (commutative, associative, distributive, inverse, identities) of integers.	1 2 3 4 5
21. Rounding-off numbers	1 2 3 4 5
22. Making a flow-chart organization for problem solving.	1 2 3 4 5
23. Finding units of precision and the greatest possible error with measurement.	1 2 3 4 5
24. Graphing inequalities of the type $ax > by + c$, where $a, b, c \in I$ (eg. $2x > 4y + 6$).	1 2 3 4 5
25. Adding and subtracting polynomials in one variable.	1 2 3 4 5
26. Studying some basic concepts of geometry (eg. point, line, plane, ray, angle).	1 2 3 4 5
27. Solving problems dealing with installment buying.	1 2 3 4 5
28. Knowing the language of algebra (eg. like terms, variable, polynomials).	1 2 3 4 5
29. Finding the least common multiple of two whole numbers.	1 2 3 4 5
30. Finding cubic measure as in the volume of a rectangular prism.	1 2 3 4 5

CONTENT ITEMS	RATING
31. Solving problems dealing with buying a home.	1 2 3 4 5
32. Solving word problems using linear equations with one variable.	1 2 3 4 5
33. Recognizing properties (commutative, associative, distributive, inverse, identities) of rational numbers.	1 2 3 4 5
34. Factoring polynomials of the type $ax^2 - c^2$, where $a, c \in I$ (eg. $4x^2 - 9$).	1 2 3 4 5
35. Solving right triangles using trigonometric ratios.	1 2 3 4 5
36. Writing frequency distribution and graphing them.	1 2 3 4 5
37. Disproving a statement by counterexample	1 2 3 4 5
38. Finding a common factor for polynomials	1 2 3 4 5
39. Finding the coordinates of the midpoint of a segment.	1 2 3 4 5
40. Knowing and applying the laws of exponents ($a^m . a^n = a^{m+n}$; $a^m \div a^n = a^{m-n}$; $(a^m)^n = a^{mn}$).	1 2 3 4 5
41. Factoring polynomials of the type $ax^2 + bx + c$, where $a, b, c \in I$. (eg. $3x^2+5x+2$)	1 2 3 4 5
42. Distinguishing between descriptive and inferential statistics.	1 2 3 4 5
43. Performing operations (addition, subtraction, multiplication, division) on irrational numbers.	1 2 3 4 5
44. Computing with percent	1 2 3 4 5
45. Knowing the relationships among the basic trigonometric ratios as related to the right triangle.	1 2 3 4 5

PLEASE COMPLETE THE FOLLOWING

(a) If you feel that such a program as proposed here should meet an aim not mentioned, would you please state that aim?

(b) If a few words, would you please state your general feelings concerning the need for such a non-university preparatory mathematics program with the aims stated earlier to be placed in Newfoundland high schools?

Appendix P

Content Items Used in the Study

Appendix P: The complete list of 90 content items in their eleven respective categories.

A - Performing operations (addition, subtraction, division, multiplication) on
1. whole numbers.
2. integers.
3. rational numbers.
4. irrational numbers.

B - Recognizing properties (Commutative, Associative, Distributive, Inverses, Identities) of
5. whole numbers.
6. integers.
7. rational numbers.
8. irrational numbers.

C - Arithmetic Computation
9. Computation involving ratios and proportions.
10. Computing with percent.
11. Solving problems using direct variation.
12. Rounding off numbers.
13. Converting from one mode of numeral to another.

D - Number Theory
14. Naming the union and intersection of given sets.
15. Defining and naming subsets of given sets.
16. Finding the greatest common factor of two whole numbers.
17. Finding the least common multiple of two whole numbers.
18. Writing prime factorization of natural numbers.
19. Finding the absolute value of rational numbers.
20. Writing numerals in scientific notation.

E - Algebra
21. Knowing the language of algebra (eg. variables).
22. Adding and subtracting non-fractional algebraic expressions. (i.e. combining like terms).
23. Knowing and applying laws of exponents. ($a^m \cdot a^n = a^{m+n}$; $a^m \div a^n = a^{m-n}$; $(a^m)^n = a^{mn}$).
24. Adding and subtracting polynomials in one variable.
25. Multiplying polynomials (monomials, binomials, trinomials) in one variable.
26. Dividing polynomials in one variable.
27. Finding common factors for polynomials.
28. Factoring polynomials of the type $a^2x^2-c^2$, $a,c \in I$.
29. Factoring polynomials of the type x^2+bx+c, $b,c \in I$.
30. Factoring polynomials of the type ax^2+bx+c, $a,b,c \in I$.
31. Solving linear equations of the type $ax+b=c$, $a,b,c \in I$.

32. Solving linear equations of the type $ax + b = cx + d$, $a,b,c,d \in I$.
33. Solving linear inequalities of the type $ax > b + c$, $a,b,c \in I$.
34. Graphing linear equations of the type $y = ax + b$, $a,b \in I$ using tables of values.
35. Graphing linear equations of the type $y = ax + b$, $a,b \in I$, by the slope-intercept method.
36. Solving quadratic equations of the type $ax^2 + bx + c = 0$, where $a,b,c \in I$, by using the Quadratic Formula.
37. Solving word problems using linear equations in one variable.
38. Graphing quadratics equations of the type $y = ax^2 + bx + c$, $a,b,c \in I$.
39. Graphing inequalities of the type $ax > by + c$, $a,b,c \in I$.
40. Solving systems of linear equations in two varialbes by the substitution and/or addition methods.
41. Recognizing a function from given sets of ordered pairs of numbers.

F.- Geometry

42. Studying some basic concepts of geometry (eg. point, line, ray, plane).
43. Defining and applying types of lines (parallel, intersecting, perpendicular).
44. Naming and identifying properties of simple plane figures.
45. Performing basic constructions using ruler, pencil, and compass.
46. Stating and applying the Pythagorean Theorem.
47. Identifying congruent triangles by the SSS, SAS, and ASA conditions.
48. Applying properties of similar triangles to solve problems.
49. Applying the Distance Formula.
50. Finding the coordinates of the midpoint of a segment.
51. Defining and identifying types of triangles.
52. Defining and identifying different types of angles.
53. Defining and identifying parts of the circle.
54. Applying formulas for finding perimeter and area of common plane figures (eg. the triangle).

G - Trigonometry

55. Defining basic trigonometric ratios using the right triangle.
56. Knowing the relationships among the basic trigonometric ratios as related to the right triangle.
57. Solving right triangles using the basic trigonometric ratios.

58. Solving applied problems using the trigonometric ratios as related to the right triangle.
59. Defining basic trigonometric ratios using the unit circle.

H - Measurement
60. Finding and computing with linear measure.
61. Finding square measure, as in area of common plane figures and solids.
62. Finding cubic measures, as in volume of rectangular solids.
63. Finding and computing with angular measure.
64. Finding units of precision and greatest possible error with measure.
65. Finding relative error and percent of error with measurement.
66. Finding measures indirectly by using similar triangles and proportions.
67. Using instruments (eg. transit) to make readings for indirect measurement.

I - Statistics
68. Distinquishing between descriptive and inferential statistics.
69. Writing frequency distributions and graphing them.
70. Finding measures of central tendancy (mean, mode, median, skewness).
71. Calculating percentiles in statistical data.
72. Calculating measures of dispersion (range, variation, standard deviation).
73. Probability (concept of randomness, approaches to probability).

J - Business and Consumer Mathematics
74. Preparing and working on budgets.
75. Solving problems dealing with installment buying.
76. Solving problems dealing with buying a car.
77. Solving problems dealing with buying a home.
78. Solving problems dealing with borrowing money.
79. Solving problems dealing with insurance (car, fire, home, life).
80. Solving problems dealing with personal bank records.
81. Solving problems dealing with sales and income taxes.
82. Solving problems dealing with personal earnings.
83. Making intelligent use of mechanical aids to calculations.

K - Logic
84. Making a 'flow-chart' organization for problem solving.

85. Putting together a logical argument.
86. Disproving a statement by a counterexample.
87. Proving a simple theorem.
88. Using deductive reasoning.
89. Determining the validity of an argument.
90. Studying the history of mathematics.